THURSDAY, JULY 23, 1891.

THE TEACHING OF FORESTRY.[1]

A Manual of Forestry. By William Schlich, C.I.E., Ph.D. Vol. II. (London: Bradbury, Agnew, and Co., 1889.)

IN a loop of the Main river in Lower Franconia, east of Aschaffenburg, rises an extensive mountainous country, clothed with almost unbroken forest of singular beauty and of enormous value. It is the Spessart, in old times known as the home and haunt of great highway robbers, but also known from time immemorial as the home of the best oak timber in Germany. The red sandstone of the Trias, which everywhere is the underlying rock in this extensive forest country, makes a light sandy loam, which, where deep, is capable of producing tall, cylindrical, well-shaped stems. Having grown up, while young, in a densely crowded wood, the oak here has cleared itself of side branches at an early age. Hence these clean straight stems, which in the case of spruce, silver fir, and other forest trees, may justly be said to be the rule, but which the oak does not produce, save under these and similarly favourable circumstances. The species here is *Quercus sessiliflora*: this species does not form pure forests, but is always found mixed with other trees, the hornbeam, the beech, and on the lower slopes of the western Schwarzwald, the silver fir. In the Spessart, the beech is associated with the oak, in the same manner as the bamboo is the chief associate of the teak tree in Burma.

In publishing his manual of forestry, the author wished in the first instance to place in the hands of the students at the Coopers Hill Forest School a handbook to facilitate their studies. That Forest School was, it may be remembered, established in 1885, in connection with the Royal Indian Engineering College at the same place, in order to give the needful professional training to young Englishmen who desired to enter the Indian Forest Department. Accordingly, when the first volume of that manual appeared in 1889, it was natural that some, who took a strong interest in the progress of forest management in the British Indian Empire, were surprised that the book did not deal with Indian trees, and that its teaching related to the oak, the beech, the Scotch pine, and other trees of Europe. By some of these zealous friends of Indian forestry the book was pronounced a failure, because it did not treat of Indian forest trees.

The principles which guide the forester in the proper treatment of his woods are the same all over the world, in India as well as in Europe. But while the application of these principles to the treatment of Indian forests is not more than thirty-five years old, the methodical and systematic treatment of European forests is of old standing, and has stood the test of experience. In the teak forests of Burma, the bamboo has a position similar to that of the beech in the oak forests of the Spessart. Oak and teak are both trees with comparatively light foliage. Pure woods of these species, while young, are sufficiently dense to shade the ground, whereas at an advanced age the wood gets thin, the canopy light, and the result is that grass and weeds appear, and that by the action of sun and wind the soil hardens and is less fertile than the loose porous soil, which is shaded by dense masses of foliage. Hence the advantage of associates, which, like the beech in Europe and the bamboo in Burma, shade the ground with their dense foliage and enrich it by the abundant fall of their leaves. But it is not only the condition of the ground which is improved by these useful associates. Teak and oak have this specialty also in common, that, when growing up alone, their stems, instead of running up into clean cylindrical boles, are apt to throw out side branches, which greatly impair the market value of the log. But when growing up in dense masses with their natural associates, these latter, crowding in as they do on all sides, around the oak in the Spessart and the teak in Burma, prevent the development of side branches and thus produce clean and regularly shaped stems.

In these and many other ways are the associates of the teak and of the oak useful friends, so to speak. Under certain circumstances, however, and at certain periods of their life, they are dangerous enemies to their more valuable companions. On the sandstone of the Spessart and elsewhere, the beech, as a rule, has a more vigorous growth than the oak; it gets the upper hand, and, unless it is cut back or thinned out in time, the oak, if both are growing up in an even mixture, has no chance. The bamboo is even more formidable as an enemy of the young teak tree. Though the teak may have had a long start; if a crop of bamboos—either the shoots of old rhizomes, or perhaps the result of general seeding of the old bamboo forest, cleared away to make room for the teak—springs up among it, the teak is doomed. As soon as the rhizomes of the bamboo have acquired sufficient strength, they produce, within a few weeks, during the rains, such a profusion of full-sized shoots, say 20 to 30 feet high, that the young teak trees among them are throttled and extinguished.

The similarity in the relations of teak and bamboo in Burma, and of oak and beech in the Spessart, has led foresters in both countries to devise similar arrangements for the regeneration of these forests. In the Spessart, when the old timber in a compartment of the forest is cut, the best places for the growth of the oak are selected, and the oak, which here sells at the rate of from 2*s.* to 3*s.* a cubic foot for sound and well-shaped pieces, is sown on soil most suitable for its development; while the beech, the timber of which only fetches about one-fifth of that amount, is allowed to reproduce naturally from self-sown seedlings over the rest of the area. Among the oak also a certain but small proportion of beech springs up, and even where pure oak woods may be the result of these proceedings, it will not be difficult, when they are sufficiently advanced, to introduce such a proportion of beech as will secure their satisfactory development. In the same way in Burma, selected areas are cleared for the growth of teak in the original forest, the clearance being effected and the teak planted with the aid of that rude mode of shifting cultivation, known as the Toungya system.

Many other instances might be quoted, in which similar practices have developed in the rearing and tending of woods in Europe and in India. The principles of sylviculture are the same everywhere, and the application of these principles to the treatment of woods in different

[1] See NATURE, vol. xli. p. 121.

parts of the globe has, in many instances, led to the adoption of similar methods; hence Dr. Schlich was right in selecting the timber trees of Europe to illustrate the application of these principles in the manual before us.

Sylviculture, the author explains, is the formation and tending of woods, and he divides his subject into four chapters. The first of these chapters treats of preliminary works, such as choice of species, fencing and reclamation of the soil by draining, the fixation of shifting sands, the breaking through of an impermeable substratum (pan) and the like. In regard to the fixation of shifting sands, an interesting account is given on p. 33 of the methods which have been most successfully practised on the west coast of France, in order to stop the progress inland of the coast dunes, and to clothe these ridges of rolling sand with a productive forest of the cluster pine (*Pinus Pinaster*). A belt, in many places five miles wide, along the coast of Gascony, and considerably further north, has in this manner been reclaimed, and the steady progress of the sand, which had covered large areas of fields and meadows, and which had destroyed numerous villages, has thus been arrested.

Chapter ii. deals with the formation of woods by artificial and natural means. The Spessart, which has been mentioned above, is an instance in which both artificial and natural means are used in order to effect the regeneration of the forest, so as to insure the production of timber of the highest possible commercial value. In most large forest districts on the continent of Europe, both the natural and artificial method are employed. As the author says on p. 178, neither the one nor the other system "is the best at all times and under any circumstances; only a consideration of the local conditions can lead to a sound decision as to which is preferable in a given case." In France, for instance, a country highly favoured by a climate uniformly moist and mild, where most forest trees produce seed more frequently than in Germany, natural reproduction may, broadly speaking, be said to be the rule and planting the exception. But in France, also, planting operations on a large scale have been carried out on the dunes of the west coast as well as on bare mountain-sides of the Alps, the Cevennes, and the Pyrenees, and, wherever necessary, planting is resorted to, to supplement the natural regeneration of the forests.

An instance in which over a large extent of country the forests are regenerated artificially may be found in the State forests of the kingdom of Saxony, together with most of the communal and many of the private forests in that country. The State forests of Saxony cover an area of 432,000 acres, and by far the larger portion of this area is stocked with pure spruce forest treated on a short rotation of eighty years, and regenerated artificially by planting. The high prices realized in this industrious and thickly populated country, even for timber of small sizes, have gradually led to the adoption of this system; and the State forests of the kingdom of Saxony are a pattern of methodical and most successful management. The forest ranges, all in charge of highly trained superior forest officers, are small, containing not more than 2000 to 3000 acres each, and many of these ranges have a steady regular annual yield of 140 cubic feet of timber per acre, and furnish a net revenue, after deducting all charges, general and local, of 100 marks per hectare, which corresponds to forty shillings an acre.

But in Great Britain also, and in Scotland especially, is the system of rearing forests by planting well understood, and it is practised over large areas economically and successfully. French as well as German foresters of great practical experience have repeatedly expressed their high sense of the skill and ability with which large plantations are formed in Great Britain at a comparatively moderate cost. But even foresters and wood-managers in Great Britain may learn a good deal from this portion of Dr. Schlich's book. Their attention might specially be directed to the author's remarks on p. 113, regarding transplants which have developed a lopsided root system, "because the trenches, into which the pricked out seedlings are placed, are often made so shallow, that the root system of the plants, instead of assuming a natural position in the ground, is altogether bent to one side."

That section of the second chapter which deals with the natural regeneration of woods, necessarily divides itself into two portions: first, natural regeneration by seed; and second, by shoots and suckers (pollards and coppice). Concise brevity is one of the great merits of Dr. Schlich's manual, and it doubtless was necessary to curtail, and to make a rigid selection of the most important matters. But the treatment of coppice woods and of coppice under standards might perhaps have been a little less brief.

As regards natural regeneration by seed, the Black Forest in South-Western Germany may be quoted as an instance where, over extensive areas, the forest is chiefly regenerated by natural means. The splendid logs of spruce and silver fir, which are floated down the Rhine in numberless huge rafts, have all grown from self-sown seedlings, and most of the young timber now growing up has had the same origin. The timber which is brought to market from these forests is much older and heavier than that sold in the forests of Saxony, but the results of management are to some extent similar. There are some forest ranges in the Schwarzwald, both in the grand-duchy of Baden and in the kingdom of Württemberg, which yield the same annual quantity of timber per acre, and furnish the same rate of net revenue to their proprietors, as those of Saxony. The term of rotation, of course, is much longer, and the system of natural reproduction takes time, hence the money value of the growing stock of old timber is very large, much larger per acre than in Saxony. The interest, therefore, on the capital invested (value of land plus growing crop) is less in this case. The discussion of these matters, however, does not appertain to sylviculture, but to forest management, with which the author will deal in a subsequent volume of his work.

As already mentioned, in France the natural regeneration of forests is the rule, chiefly owing to its wonderfully favourable climate. Large areas, mainly of private and communal forest, are managed in admirable style, as coppice woods and as coppice under standards. The treatment of high timber forests also, and their regeneration from self-sown seedlings, by means of a regular system of successive cuttings, has in France been brought to a high state of perfection. This circumstance renders the French forests specially valuable as a field of instruction for foresters proceeding to India. For in that large country, though planting has been commenced and must

necessarily be carried on in some instances on a large scale, yet every effort ought to be made to develop good systems of natural regeneration in the different provinces.

On pp. 132–64 the author gives a clear account of the different systems which have in course of time been devised, in order to effect the natural regeneration of woods by seed. Under the more favourable climate of France the desired object is generally effected by a simple and to some extent uniform system of successive cuttings. In Germany, on the other hand, where droughts are frequent, frosts severe, and where good seed years generally are of rare occurrence, the system of regular successive cuttings, which originated in Germany, in many cases was found to fail, and accordingly, some sixty or seventy years ago, the tide set in in favour of artificial reproduction. A reaction, however, has for good reasons taken place in many parts of the country, and during the last thirty years German foresters have been busy in adapting the system of natural regeneration to the peculiar conditions of each forest district. Indian forest students should go to France, in order to become impressed with the fact that under favourable circumstances natural regeneration of high forests may be effected by a simple and easy system of treatment. In German forests, on the other hand, they should learn how the difficulties of a climate frequently unfavourable have been successfully overcome by devising systems of treatment suitable to the requirements of each locality, and the knowledge here acquired will be most useful, nay, necessary, to them in India, where the conditions of climate by no means always favour the natural regeneration of the more valuable forest trees.

Space forbids a full discussion of this most important and interesting subject. This portion of Dr. Schlich's book, if supplemented by the study of forests on a large scale, particularly in Germany, will be most useful to foresters who may be called upon to devise methods of forest treatment in other parts of the globe, be it India, Australia, South Africa, or North America.

Closely allied to the subject just adverted to is what the author says in the fourth section of the same chapter regarding the formation of mixed woods. Pure woods, consisting of one species only, are exposed to various risks, from which mixed woods are exempt. Hence, in most Continental forests, there has of late years been a strong tendency in the direction of favouring the growth of mixed woods, such as oak and beech, oak and hornbeam, oak and silver fir, Scotch pine and beech, and the like. It goes without saying, that operations in this direction, in order to be successful, must be guided by careful study of the mode of growth and of the peculiar requirements of the different species in different places and under different conditions. Something has been said above regarding the treatment of mixed woods of oak and beech in the Spessart. But it does not follow that oak and beech behave in the same manner everywhere. On certain kinds of shale, belonging to the Devonian formation, for instance, the oak rather than the beech has the tendency to take the lead, and here mixed woods of oak and beech can be produced from self-sown seedlings much more easily than would be possible on the sandstone of the Spessart. Again, along the foot of the Western Schwarzwald, where, as already stated, the silver fir is associated with the oak, this tree, though a shade-bearer like the beech, renders it much easier for the oak to hold its own in an even-aged mixed wood, because in its early youth it grows very slowly, thus giving the oak a good start in life.

Chapter iii. teaches how woods should be tended during early youth and afterwards. Passing over what the author says regarding cleaning of young woods and pruning, we come to thinning operations. On p. 209 an interesting statement is given showing the number of trees per acre in certain mixed woods of the Schwarzwald. The figures are as follows:—

Age of wood in years.	Number of trees per acre.
20	3960
40	1013
60	449
80	346
100	262

Thus, during the life of a wood, and this holds good in all cases, the number of trees per acre decreases gradually from several thousand to a comparatively small number at maturity. When, as usual, the object is to produce high class timber, with clean well-shapen stems, the rule is, as the author correctly states it: "The wood should be thinned lightly until towards the end of the principal height growth; then the thinnings should gradually become heavier, so as to assist a selected number of trees by the gradual removal of all those which are inferior and diseased." In its youth the wood is crowded, the young trees maintaining a severe struggle for existence. The weaker trees are suppressed and some are actually killed, while the rest are either dominant trees, with their head well above the others, or dominated, though not suppressed. Formerly thinnings were generally done by rule of thumb, the dead, oppressed, and a portion of the dominated trees being removed. But it is obvious that, when the object is to produce valuable timber, thinnings must so be managed, that the trees which are destined to attain the term of rotation, and which will form the final crop to be cut down, in the example here given, 262 trees per acre 100 years old, shall be sound and regularly shaped. It is obvious that to attain this object dominant trees also may occasionally have to be removed, if unsound, spreading, or irregular shaped, and this is properly recognized by the author. He justly adds that in such cases dominated and even suppressed trees may have to be spared in order to keep the ground well under cover. Such would be the practice in the case of woods consisting of one species only, or of several species of equal value. Where one species, such as oak or teak, is of much greater value than the others, all thinnings must, as a matter of course, be so arranged as to favour this species at the expense of the rest.

So far concerning the thinning of crowded woods. The last section of the same chapter deals with the tending of open woods for the production of large timber. Into this subject, which is one of some difficulty, though of great importance, it would lead too far to enter on the present occasion.

Chapter iv. contains sylvicultural notes on British forest trees, with notes (by Prof. H. Marshall Ward) on botanical characters serving to distinguish the principal British forest trees. The two species of oak dealt with in

the sylvicultural notes are *Quercus pedunculata* and *Quercus sessiliflora*. Botanists are well aware that the maintenance of distinctive characters between these two and others of the European species of *Quercus* is difficult; so much so, that the best authorities on English trees have decided to re-establish the old species of Linnæus, *Quercus Robur*, and to regard the two species named merely as forms or varieties. The forester has a different task, and for him the mode of growth and the requirements of these two oaks are so different that he must keep them separate. It will suffice to mention one point, which has not perhaps been brought out sufficiently by the author. The mixed woods in which *Quercus sessiliflora* is associated with the beech, the hornbeam, and the silver fir have been mentioned above. In natural high forests this species is only found in company with other trees, and particularly with the three kinds named. The pure or nearly pure coppice woods of *Quercus sessiliflora* in France and Western Germany are an exception; these, however, have been converted into pure woods by the long-continued cutting out of beech, hornbeam, and soft woods. *Quercus pedunculata*, on the other hand, *does* form pure high timber forests of considerable extent. Such are found both in Northern and Southern Europe, not on hilly ground, but always on deep alluvial soil. Instances are the forests on low ground along the Elbe and other rivers of North Germany, the magnificent pure forests of that tree on the banks of the Adour river near Dax in Gascony, and similar ones in the peninsula of Istria, south of Trieste. There is underwood on the ground in the forests named, but it merely consists of thorns and low shrubs. The two species, *Quercus sessiliflora* and *pedunculata* have different requirements and require somewhat different treatment. This, however, is a small matter. These sylvicultural notes are most valuable, and it is satisfactory that the Weymouth pine and the Douglas fir have been included among them.

The second volume of Dr. Schlich's manual, like the first, will be an immense help to the students who are trained at the Coopers Hill College for forest service in India. It will be a great boon to all who are charged with the management of forests in India, in the colonies, and in the United States of North America. And it may perhaps be hoped that in Great Britain also this excellent book will in course of time tend to awaken a more general interest in the good management of its woodlands, which are very extensive, and which some day may be of considerable importance and of great value to their proprietors.

D. BRANDIS.

THE APPLICATIONS OF MODERN CHEMISTRY.

Dictionary of Applied Chemistry. Vol. II. (Eau-Nux). (London: Longmans, 1891.)

THE editor of a dictionary of applied science, such as the volume before me, has in these days no enviable task to perform: much is required of him, and the difficulties with which he has to contend are great. Prof. Thorpe has acquitted himself well, for though there may be, indeed there are, many points with which the expert can find fault, yet these are generally matters of detail, and on the whole the work has been satisfactorily done, so that the second volume will be found to be quite up to the high level of the first. The industries which owe their foundation to the science of chemistry now progress with such giant strides, that processes which last year were the newest and best may this year be so improved as to be rendered obsolete, so that an article printed at the commencement of a volume may become antiquated before the last article is in type, whilst data unattainable when the article was written are superseded by some more recently published. As an example of this, I may take that upon "gas coal," written by a most competent authority, Mr. Lewis Wright. On p. 177 will be found a table giving the weight of coal carbonized by all the authorized gas undertakings in the kingdom, exclusive of those of local authorities, for the year ending March 25, 1886. Since these tables were printed, a Board of Trade return for 1890 has been published. In 1886, 8,378,904 tons of coal were carbonized; in 1890 the figure rose to 9,663,011. In 1886 the mileage of mains was 18,967; in 1890 it had increased to 21,584. These numbers point out the enormous extent of the coal-gas industry in this country, and show clearly that it is not suffering from the competition of electric lighting; indeed, this competition is favourable to the sale of gas, for we see that our streets are now better lighted than formerly, and the consumption of gas in many shops is increased, in order to vie with the splendour of their neighbours' electric light.

As a critic is bound to criticize, I may point out some few faults of commission and omission which have struck me in reading through this generally excellent article.

The important steps which have recently been taken in many large works for charging and drawing the gas retorts by mechanical means are barely referred to. Great economy is doubtless effected where such labour-saving mechanical appliances have been adopted, and a description of these would have been of interest, as the labour agitation in our gas-works has brought engineers face to face with this question. Another point upon which a statement would have been of value is the most improved arrangements of the purifying house, and the methods adopted for charging and discharging the purifiers. That "the whole of the sulphuretted hydrogen, carbonic acid, and carbon disulphide can be easily and economically removed" (p. 200) by a combined system of oxide and lime, and with a proper arrangement of purifiers, is a statement to which many gas engineers will demur. The London companies, especially, who have a legal standard limit for sulphur compounds, find it both difficult and expensive to keep down the impurities to the necessary point. The illustrations given in this article are scarcely worthy of the letter-press. Figs. 22 and 23 do not give an idea of the construction of a modern gas-holder, some of which now have the enormous capacity of ten million cubic feet, and are marvels of engineering skill. A description of the latest improvements would have added interest to the article.

As an instance of the rapid progress of an industry interfering with an adequate account being published in the early pages of such a volume, I may refer to the article on electro-plating, by Prof. W. C. Williams, which, although giving a clear account of the older processes, scarcely represents the position of to-day. Thus no reference is found to recent methods of the electro-deposition of metals, as, for example, the Elmore copper process, or to that of plating by aluminium; nor does any mention occur of the electric power suitable or used for depositing metals.

To justify the opinion that this volume is no unworthy successor to that published last year, I would refer to a few articles which are certainly the best I know on their several subjects. First, "Explosives," by W. H. Deering, coming from the pen of one who has had long experience in the Chemical Department of the Royal Arsenal, Woolwich, is, as we should expect, up to the level of the time, and in every respect excellent. Second comes Prof. Percy Frankland's article on fermentation. No one is more competent than he to write on this most fascinating subject, and his article reads like a novel, and even better, for "truth is stranger than fiction"; and Percy Frankland tells his story so clearly and well that I will not spoil the pleasure of his readers—and they ought to be many—by any attempt to abstract its results. Thirdly, the article on "Matches," by Mr. Clayton, may be cited as an admirable treatise on this important branch of chemical manufacture, condensed into 24 pages. Not the least important contribution are the nine tables giving, in chronological order, lists of the numerous patented and other inventions in this department of chemical technology. Lastly, I will select Mr. Wynne's exhaustive article on naphthalene as perhaps the most able and valuable in the whole volume. When we learn that, although it occupies 65 pages of the dictionary, it treats exclusively of the derivatives of one hydrocarbon, and only of those of them which are now used in the arts, and valuable for industrial purposes, we begin to form an idea of the extent and importance of the results of modern organic research, which has opened out regions illimitable, leading to practical results such as the chemists of the last generation would have deemed impossible.

In a dictionary of applied science the question of selection is even more difficult than in a similar work of pure science. Here the knowledge and tact of the editor are especially called into play. Prof. Thorpe has, I think, chosen well, but here and there some pages are taken up with matters of which I should be glad to learn the present industrial value—for in the future all may have a use. Thus I find close together the following: elaidic acid, ericolin, erucic acid, erythrol—all, doubtless, compounds of scientific interest, but hardly, I would venture to suggest, of industrial importance.

As I said of the first volume, so I may say of the second—that it does credit to the authors of the articles, to the editor, and to the public-spirited publishers. It is good that English scientific literature keeps up its prestige for thoroughness, clearness, and conciseness, and that in this volume of the dictionary no falling off from this standard is visible.

H. E. ROSCOE.

THE FISHES OF SWITZERLAND.

Faune des Vertébrés de la Suisse. Par Victor Fatio. Vol. V. "Histoire naturelle des Poissons." 2me partie, avec 4 planches, pp. 576. Supplémens, pp. 13. (Genève et Bale: H. Georg, 1890.)

AS more than eight years have elapsed since the publication of the last volume of the "Faune des Vertébrés de la Suisse," I may preface this notice with a few words as to the general scope and progress of this important work. The first volume, published in the year 1869, was devoted to a detailed account of the Mammals of Switzerland; the third (1872) to the Reptiles and Batrachians; and the fourth (1882) to a part of the Fishes (Acanthopterygians and Cyprinoids); the second volume, which will contain the Birds, being still in course of preparation.

The part now published, which is the fifth of the series, treats of the remaining half of the fishes, notably the Salmonoids, which take up nearly two-thirds of the volume, and whose study has probably occupied the author by far the better half of the eight years which he has devoted to its preparation.

As regards the plan of the work, the thoroughness and originality with which the author treats his subject, and the fairness of his criticism of his predecessors, I may be allowed to refer to what I have said in my notice of the first volume of the Swiss ichthyology (NATURE, vol. xxvii. p. 220); stating again that "this work rises far above the level of a local publication, and is of as great value to the student of European freshwater fishes as to the Swiss naturalist."

The species treated of in the present volume are the following: 3 loaches, 2 shad, 8 Coregoni, 1 grayling, 1 salmon, 1 trout, 1 char, 1 pike, 1 Silurus, 1 eel, 1 burbot, 1 sturgeon, 3 lampreys. These bring the total number of Swiss freshwater fishes to 51.

The hydrographic system of Switzerland comprises the head-waters of four rivers, viz. the Rhine, Rhone, Po, and Danube. The first contributes the largest contingent to the Swiss fish fauna, viz. 42 species; however, this number is reduced to 28 in the upper course of the river, above the falls of Schaffhausen. At an altitude of between 600 and 900 m. the majority of the Cyprinoids, and between 1000 and 1100 m. the perch, salmon, eel, and burbot disappear. Only five species remain at that altitude, viz. the miller's thumb, minnow, loach (*N. barbatulus*), grayling, and trout—species which likewise have the greatest horizontal range in a northward direction. Between 1800 and 1900 m., first the grayling and the loach are lost, and then successively the trout, miller's thumb, and minnow. The trout, however, can still subsist in lakes up to 2630 m., into which this fish has been introduced. The Rhine contributes five types of fishes to the Swiss fauna which are not found in the other hydrographic systems, viz. *Acerina* (the pope), *Rhodeus*, the salmon, the sea lamprey, and the stickleback. The absence in the southern and eastern waters of the four first is readily accounted for by their distribution generally; but it seems very singular that a fish like the stickleback, which in the west of Europe extends far southwards, and reaches even Algeria, and which is

supposed to be capable of easy transportation by aquatic birds, should not have made its way into the other river-systems.

The fishes contributed by the Rhone fall into two categories—one comprising those of the part of the River Doubs which is within the political boundaries of Switzerland; the other including the species of the Rhone proper above the "Perte." The latter are computed to be 20 in number, and do not call for special remarks.

The fishes of the Po show a marked difference from those of the Rhine and Rhone. This system is represented in Switzerland by the tributary Ticino, into which 23 species enter, out of a total number of 44 Po species. Although there is no mechanical obstacle to their ascent, the fishes of the Po, used to a warmer climate, avoid ascending into the cold waters from the Alps; and M. Fatio observes, also, that generally these southern fish do not ascend to the same high altitudes as those of the Rhine. Eight of the Ticino species are strangers to the rest of Switzerland, viz. a goby (*Gobius*), which has ascended from the sea; five Cyprinoids, which may be regarded as southern representatives of northern forms; *Cobitis tænia* and *Alosa finta*.

Of the 68 species belonging to the fauna of the Danube, only four find their way into Switzerland through the River Inn, viz. the miller's thumb, minnow, grayling, and trout. This is owing to the great elevation of this river at its entrance into the country (1000 metres).

Ichthyologists will turn with particular interest to that part of the volume which contains Dr. Fatio's views on, and his treatment of, the Salmonids; for my own part, I could not help feeling some surprise at what appears to me a somewhat inconsistent mode of dealing with this subject. Whilst the author distinguishes not less than eight Swiss forms worthy of binominal designation in the genus *Coregonus*, he admits, besides one species of char (*Salmo umbla*), two equivalent forms only in the genus *Salmo*, viz. the salmon and the trout, for which latter the collective term *Salmo lacustris* is chosen. If a student of the European fauna, or any part of it, arrives at the conclusion that the various forms of river, lake, and sea trout cannot, and should not, be held to be deserving of specific distinction, no one will deny that there are very strong arguments in favour of this view. In my own experience it does not seem to be desirable to adopt that course—first, because there are certain well characterized and well localized forms which the practical fisherman will always distinguish, and of which the naturalist has, somehow, to take notice; and, secondly, because the ichthyologist who goes beyond the narrow limits of a fauna, and has to deal with the trout of the whole northern hemisphere, is compelled by technical considerations to admit those distinctions. I myself go a step further, and consider it a mistake not to separate, specifically, from the extremely variable *Salmo fario*, such strongly differentiated forms as *Salmo lemanus*, *S. marsilii*, *S. venernensis*, or the Loch Leven trout of the older authors. But if, as is Dr. Fatio's opinion, no taxonomic value is to be assigned to the characters by which those forms of trout are differentiated, then I cannot see why in *Coregonus*, a closely related genus of the same geological age and distribution, similar organic modifications should be considered to have a different bearing.

As is well known, there are some very obscure facts in the life-history of Salmonoids which greatly contribute to the difficulties of their study. Dr. Fatio discusses them very fully, but we must pass over the deductions he draws from them, with the exception of the phenomenon of sterility as a cause of change in the outward appearance of a fish. Sterility among Salmonoids is apparently much more common in Switzerland than in British waters; but ever since Siebold has drawn attention to it, its effects seem to me to have been exaggerated. At any rate, I have received specimens as, and, indeed, with all the outward characters of, the so-called sterile trout of Lake Constance, which had fully matured ova.

Like errata, appendices of works are only too often overlooked; I would therefore mention that the present volume concludes with important supplements to those which contain the Mammalia and Reptilia.

The volume is illustrated with four plates—one representing the *Bondelle* of the Lake of Neufchâtel, the others various details of structure, chiefly of Salmonoids.

I trust that before many years Dr. Fatio will be able to complete his work, for which, not only his countrymen, but every student of the European fauna, owe him a debt of gratitude. ALBERT GÜNTHER.

THE HISTORY OF MARRIAGE.

The History of Human Marriage. By Edward Westermarck. (London: Macmillan and Co., 1891.)

BY "history" our author means "natural history" (p. 19), and his reason for using the odd term "human marriage" is that "marriage, in the natural history sense of the term, does not belong exclusively to our species" (p. 6). According to him, "marriage is nothing else than a more or less durable connection between male and female, lasting beyond the mere act of propagation till after the birth of the offspring." In this sense marriage is "an almost universal institution among birds," and "occurs as a rule among the monkeys, especially the anthropomorphous apes, as well as in the races of men" (p. 20). Among mankind it is universal, and in all probability is "an inheritance from some ape-like progenitor" (p. 538). In this book, therefore, marriage is taken to mean what ordinary people call "pairing," and the professed subject of the volume is the natural history of the habit of pairing in the human race. But surely, on any proper use of terms, marriage is not simple pairing, but such pairing as is protected and regulated by law, or by the public opinion which in rude societies stands for law. And the history of an institution which is controlled by public opinion and regulated by law is not natural history. The true history of marriage begins where the natural history of pairing ends.

Mr. Westermarck's definition leads him to go at length into various topics that really belong to natural history, but have little or nothing to do with the history of marriage in the ordinary sense of the word; such as sexual selection, and the means used by one sex to attract the other. But he also deals with polyandry, kinship through females only, infanticide, exogamy—all of which belong to the sphere of law and custom, within which his definition of marriage is totally inapplicable. To treat these topics as essentially a part of the natural history of

pairing involves a tacit assumption that the laws of society are at bottom mere formulated instincts; and this assumption really underlies all our author's theories. His fundamental position compels him, if he will be consistent with himself, to hold that every institution connected with marriage that has universal validity, or forms an integral part of the main line of development, is rooted in instinct, and that institutions which are not based on instinct are necessarily exceptional, and unimportant for scientific history. One does not expect a tacit assumption to be carried out with perfect consistency; but, on the whole, Mr. Westermarck's results correspond with his assumption, and have no evidence to satisfy anyone that is not prepared to share the assumption with him.

To show this at length would exceed the limits of a short review; let us, however, take, as a crucial test, Mr. Westermarck's explanation of the origin of exogamy. He believes that exogamy and all laws of incest originate in an instinctive aversion to sexual intercourse between persons living closely together from early youth (p. 320), and the origin of this instinct he explains as follows. He thinks it can be proved that consanguineous marriages are detrimental to the species. Now,

"among the ancestors of man, as among other animals, there was, no doubt, a time when blood-relationship was no bar to sexual intercourse. But variations, here as elsewhere, would naturally present themselves; and those of our ancestors who avoided in-and-in breeding would survive, while the others would gradually decay and ultimately perish. Thus an instinct would be developed which would be powerful enough, as a rule, to prevent injurious unions. Of course, it would display itself simply as an aversion on the part of individuals to union with others with whom they lived; but these, as a matter of fact, would be blood relations, so that the result would be survival of the fittest" (p. 352).

The obvious and fatal objection to this theory is that it postulates the existence of groups which through many generations (for the survival of the fittest implies this) avoided wiving within the group. And this is, in fact, a well-established custom of exogamy, so that the theory begins by postulating the very custom that it professes to explain. Moreover, it is questionable whether Mr. Westermarck's theory even helps to explain the wide diffusion of exogamy. For where wiving outside the local group is the rule, all neighbouring groups mingle their bloods, and consanguineous marriages are not escaped.

It is not surprising that Mr. Westermarck, with his habit of looking at the whole subject from a biological point of view, should have little sympathy with the speculations of a man like McLennan, to whom marriage is not a mere fact of natural history, but a relationship resting on contract and approved by custom or law; and who in all his investigations gives weight to the action of human intelligence as the decisive factor in social progress. But it is a pity that this lack of sympathy has sometimes prevented our author from appreciating the full scope of McLennan's methods and arguments. What is said about the Levirate at pp. 510-14 could not have been written if Mr. Westermarck had carefully read the discussion of the subject in "The Patriarchal Theory"; nor, to mention a trivial matter, would he in that case have made the error of confounding the Hindu Levirate with the Nyoga (p. 514, *note*). And here I may also note that the criticism of McLennan's views of exogamy does not take account of the posthumous and very important paper published in the *English Historical Review* for January 1888.

These are details: what is more to be regretted is that Mr. Westermarck has not learned, as he might have done from McLennan, a sounder method of handling the evidence drawn from the usages of rude societies. The very possibility of reconstructing the history of human progress rests on the fact that all over the world mankind has been moving in the same general direction, but at very various rates, and that careful reasoning, aided especially by the observation of cases which exhibit a state of transition (*e.g.* from one type of kinship to another), enables us to bring out the order in which the various observed types of social structure succeed one another. Of all this, Mr. Westermarck does not seem to have the least idea. He collects facts about the prevalence of kinship through males or through females, about forbidden degrees, and so forth, without ever rising to the conception that the evidence is good for anything more than an *inductio per enumerationem simplicem*. This is not the way in which real progress can be made.

W. ROBERTSON SMITH.

OUR BOOK SHELF.

Geological Map of Monte Somma and Vesuvius. Constructed by H. J. Johnston-Lavis, M.D., M.R.C.S., B.-ès-Sc., F.G.S., &c., during the Years 1880–88. Scale, 1 : 10,000 (6·33 inches = 1 mile). In Six Sheets, with a Pamphlet entitled "A Short and Concise Account of the Eruptive Phenomena and Geology of Monte Somma and Vesuvius." (London: George Philip and Son, 1891.)

DURING the latter half of last century, the changes taking place in Vesuvius were carefully studied and faithfully chronicled by an English diplomatist—Sir William Hamilton; in the closing years of the present century, the famous volcano has found an equally indefatigable investigator and historian in the person of an English medical man resident in Naples—Dr. Johnston-Lavis. In 1884, Dr. Johnston-Lavis laid before the Geological Society an elaborate memoir, in which he detailed the theoretical conclusions at which he had arrived after long and patient study of the various sections exposed on the flanks of Somma and Vesuvius. He has now published a very valuable addition to this work, in the form of a map constructed on the basis of the topographical surveys of the Italian Government, and coloured in accordance with the views to which he has been led by his long and painstaking geological labours.

In his general memoir on the geology of Somma and Vesuvius, the author has divided the time covered by the history of the volcano into four "eras," and these again into eight "phases," while some of the latter are subdivided into "periods." In colouring the map, it has, of course, not been found possible to give expression to anything like such a minute classification of the rocks composing the mountain as is implied in such a scheme. The legend on the map recognizes as the great landmarks in the past history of the volcano the paroxysm of 79 A.D. and the great eruption of 1631. The pamphlet accompanying the map, however, gives a very useful and readable abstract of the earlier memoir; and the map and descriptive pamphlet together cannot fail to prove of the greatest service to all students of vulcanology. By their

publication, Dr. Johnston-Lavis has added one more to the long list of valuable services which he has rendered to geological science.

Les Sciences Naturelles et l'Éducation. Par T. H. Huxley. Édition Française. (Paris : Baillière et Fils, 1891.)

THIS is a translation of various essays with which all English students of Prof. Huxley's writings have long been familiar. Most of them deal with various aspects of the question as to the true place of science in a proper system of education ; and no one who has read them in their original form is likely to have forgotten the philosophical power with which the subject is discussed, or the admirable lucidity, strength, and grace of the writer's style. With his educational papers Prof. Huxley has associated his well-known essays on Descartes and Auguste Comte, which cannot fail to be of interest to French readers. He contributes to the volume a short preface, in which he refers with satisfaction to the astonishing advance that has been made in the recognition of science as an instrument of education. He warns men of the younger generation, however, that the battle has only been half won, and that much serious work will have to be done to secure the triumph of the principles for which he has contended Of the translation it may be enough to say that Prof. Huxley cordially commends it as a faithful rendering of his thought.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

W. E. Weber.

IN the article on Wilhelm Weber (NATURE, July 9, p. 229) no mention is made of the fact that Weber and Gauss in 1833 invented and constructed a telegraph connecting the Physical Laboratory of the University in Göttingen with the Observatory. In Germany they are for this reason said to be the inventors of telegraphy. This is, to say the least, a somewhat sweeping statement, as the possibility of communicating by electricity was known long before that time. However, there is no doubt that Weber and Gauss played some part in introducing telegraphy into practice. For my part I consider the purely scientific work of either of the two men more glorious. For the enormous practical consequences of telegraphy have nothing to do with the scientific merit of the invention. Nevertheless I think that an article on Wilhelm Weber would not be complete without entering into this subject. C. RUNGE.

Hanover, Technische Hochschule, July 13.

[Conducting wires were erected between the Göttingen Observatory and the Physical Cabinet of the University, distant about three-quarters of an English mile, in order to obtain accurate comparisons of the clocks. But, in addition to systematic daily transmission of time, the wires were from the first frequently used for telegraphic purposes, though, with the first arrangements, only two letters could be sent in a minute.—G. C. F.]

Earthquake Shocks in Italy and Australia.

BY a telegram from London, which appeared in the newspapers here on the 12th and 13th inst., information is given of a severe earthquake in Italy (about Vesuvius) on June 7 (Sunday). On that day, several distinct and well-marked shocks were felt over parts of the south of Australia, and as there may be some connection between these seismic disturbances in both hemispheres, I give below the times and other information of the disturbances experienced here.

None of the disturbances reported in Australia seem to have been more than a "shake" or *sharp tremor* sufficient to shake windows and rattle crockery, &c., but they were enough, in some instances, to produce feelings of nausea.

June 7, at 2.5 p.m., the first disturbance occurred, and was felt all around Melbourne and over a surrounding area of 360 square miles.

June 7, at 2.45, another shake (not so great as the first) was also felt ; in this case it was felt most severely to the east of Melbourne.

June 7, at 7.20, smart shock felt at Kapunda, South Australia.

June 7, at 6.45, slight shock felt at Stockport, South Australia The direction of motion is variously given as from north-west to south-east, south-east to north-west, and south-west to north-east, north to south, south to north, &c. The conclusion arrived at is that the wave was from south to north nearly. The approximate geographical positions of the several localities where these disturbances occurred are as follows :—

	Lat.	Long.
Stockport ...	34° 21′ S.	138° 57′ E.
Kapunda ...	34 21 S.	138 46 E.
Melbourne ...	37 50 S.	144 58 E.

Melbourne, June 15. R. L. J. ELLERY.

P.S.—It is quite probable the shocks felt at Kapunda and Stockport were one and the same, as time is not very strictly kept in districts distant from large towns in Australia.

Force and Determinism.

I SEE nothing to criticize in Mr. Dixon's middle paragraph, wherein he accurately summarizes some of the definitions of mechanics, except that I should prefer to express the meaning of his last sentence by saying that, if in any department something simulated the functions of, say, energy, without obeying its precise mechanical laws, then the distinction between energy and that something should be clearly recognized, and another name be given to it.

I find it rather common for "life" to be thought of and classed under the head energy, either by the use of a phrase such as "vital energy," or in a more direct way ; the reason being apparently that organisms while living simulate some of the functions of energy, and cease to do so when dead. It was against this confusion that I wrote on p. 491 (vol. xliii.).

Life has not yet been included in the domain of physics, neither has it, so far as I am aware, been much studied under the head biology.

And yet the disturbing action of live animals will have to be formulated and attended to some day, even in physics ; for, though they generate no energy nor affect its amount in the slightest degree, they certainly control it and direct it in channels it would not otherwise have taken. The question is, How do they manage this? And one answer that may be given is, By exerting directive or guiding forces on matter.

Of course they are not limited to this, but in so far as they do work their action is fairly understood : the energy displayed by a gang of navvies is known to be derived from the little tin cans they bring with them : the energy is not theirs but their victuals', they simply direct it. But how comes it that they can direct the energy of victuals and atmosphere into the erection of the precise bridge or other structure which has been planned? What determines the direction of the transfer of energy?

The same question may doubtless be asked in connection with inanimate activity : I would not be understood as assuming for certain any clear or essential difference between the two cases ; but in neither case do I know the answer.

The action of force in doing work, *i.e.* transferring and transforming quantities of energy, has been thoroughly attended to.

The action of force in directing and guiding the transfer of matter and energy does not seem to me to have been seriously contemplated.

In his most recent book ("The Philosophical Basis of Evolution") Dr. Croll attacks the problem, and says that guidance is effected by "determinism" not by force. But that cannot be admitted ; for without force the motion of matter cannot be changed in direction any more than in speed. *Force* is certainly necessary to direct the motion of matter, it is *energy* only which is unnecessary ; for any transfer of energy that may occur is an accidental, not an essential, concomitant.

I determine to move an object : it may be only my finger, or it may be a wheelbarrow. In so far as I do any work in the action I do so at the expense of my food, and there is nothing but a chemical difficulty about that. The mystery begins when one

asks how I manage to direct that energy along a definite path so as to produce a willed result. The only answer I know is, "By a nervous impulse liberated from brain centres." But what is it that is thus liberated? and what pulls the trigger to liberate it?

By mechanical analogy one would say that energy can only be guided by force, and that force must therefore be exerted in the brain cells; but, if so, the relation between force, which is a mechanical thing, and will or life, or whatever it is, which is a psychological thing, demands investigation.

I trust that Mr. Lloyd Morgan will help me to get my ideas on these subjects straighter, and will point out if I have made any assertions which are obviously erroneous or grotesque. The borderland of psychology and physics is the last place in which I would like to dogmatize; and in a letter like this I see no harm in airing confessedly immature and groping notions, in the hope that ventilation may clear the air. So far as physics only is concerned, I have stated how I regard the phrase "expenditure of energy" in the *Philosophical Magazine* for June 1885

With regard to the crux raised in Mr. Dixon's last paragraph, that nothing but matter can exert force, because the acting matter must receive an equal opposite momentum, it may perhaps be just worth noticing that an infinite mass can absorb any amount of momentum without receiving a trace of energy or being itself in any way affected. OLIVER J. LODGE.

Liquid Prisms.

I OBSERVE in NATURE of July 2 (p. 207), that it is stated Herr Wolter has recently recommended α-monobromnaphthalene as a substance peculiarly fitted for study of the ultra-violet part of the spectrum, by reason of its high dispersive power and transparency for the ultra-violet rays.

Perhaps I may be permitted to state that Mr. Madan published an account of its dispersion and refractive power in the *Phil. Mag.*, and recommended its use in liquid prisms. Having made use of many other substances, including methyl salicylate, I gave this a trial. For ordinary work it would be excellent if colourless; but unfortunately, no matter how free from colour it may be when freshly prepared, long-continued use causes it to become yellow, and in considerable thicknesses even dark brown. For the ultra-violet rays it is undoubtedly better than carbon disulphide, but nevertheless practically useless, as the line N, which it is said to transmit, has a wave-length of 3580, so that only about one-half of the ultra-violet solar rays are observable with it. In metallic spectra almost all lines of interest lie between 3580 and 2000. A liquid which I considered to possess much superior optical properties is *mercuric methide*; it is perfectly colourless, and of such density that flint glass will float upon it. When the glass is immersed it becomes invisible, consequently the refraction and dispersion of the liquid are probably exceptionally high. As far as I can recollect, being without access to my notes, a thickness of 50 millimetres freely transmitted all rays to about λ 2900—that is to say, the entire solar spectrum. Unfortunately, it has its drawbacks, in being somewhat volatile, and its vapour highly poisonous.

Stonehaven, N.B. W. N. HARTLEY.

The Identification of Templeton's British Earthworms.

BETWEEN the years 1829 and 1836 the first series of Loudon's *Magazine of Natural History* appeared in nine volumes. In the last volume we find some notes on earthworms by Templeton, which have proved somewhat puzzling to students of more recent times. I have been fortunate enough to follow Templeton in some of his researches, and am able to correct and verify certain of his statements.

The *Lumbricus xanthurus*, Temp. (*op. cit.*, ix. 235), is the angler's gilt tail, and as such is synonymous with *Lumbricus puter*, Hoffm., and *Dendrobæna Boeckii*, Eisen. *Lumbricus gordianus*, Temp. (*loc. cit.*), is undoubtedly the mucous worm (*Allolobophora mucosa*, Eisen), or one of its near allies, all of which are to be found of a pale rosy colour coiled up into a knot at certain times of the year.

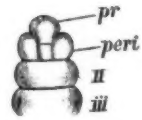
It is to *Lumbricus omilurus* (= *Omilurus rubescens*, Temp., *loc. cit.*), however, that I wish to direct special attention. Grube, in 1851 ("Familien der Anneliden," p. 101), placed it, with Templeton's other worms, in a list of species which were insufficiently characterized for systematic purposes. Vejdovsky, in 1884 ("System und Morph. der Oligochæten," p. 62), places it among the questionable species without note or comment, and, so far as I can gather, no one has been able to throw light upon it since.

Templeton says the worm is never larger than half the size of *L. terrestris*, L., is of a bright reddish-brown, with the tail very flat, and the body *unfurnished with a belt at the position of the sexual organs*. It would be very easy to suppose from this somewhat vague account that the writer had only seen immature specimens; but a little careful study of his words shows that he knew what he was writing, and that his worms were mature. Now a mature species of *Lumbricus* without a clitellum is certainly an anomaly, and needs investigation.

While collecting Annelids recently, I came across half-a-dozen specimens which at first sight exactly resembled *Lumbricus rubellus*, Hoffm. I took them home for verification, and immediately observed the difference. I had obtained with them typical specimens of *rubellus*, which enabled me to make a careful comparison of the two species in a living state.

The following is a description of the worm as I wrote it down before observing Templeton's account.

Colour dark brown, iridescent on the dorsal surface anteriorly, becoming lighter towards the posterior extremity, which is flesh-coloured or light red, pink ventrally. Prostomium dovetailing completely into the peristomium, and possessing a transverse groove in the middle, as shown in the accompanying sketch.



Lumbricus rubescens. Segments 1 to 3 with prostomium entirely cutting the first segment or peristomium.

Segments not annulated (or divided by transverse rings). Length about 3 inches, total number of segments about 120. Setæ in couples as in typical Lumbricus. Male or spermiducal pores on segment 15 with papillæ, which, however, do not extend over the neighbouring segments. Body cylindrical in front, flattened posteriorly. The dorsal pore between 5 and 6. It appeared at first between 7 and 8, but by using polarized light on the cuticle when spread on a glass slip the whole series of pores in one or two specimens became clearly visible from the fifth segment backwards.

On the ventral surface prominent papillæ appeared on segments 28 and 29, such as are often seen on typical *L. agricola*, Hoffm. Now came the crucial question, Is there no clitellum? By studying all the examples carefully, I found that they agreed in one particular. The segments 34 to 39 differed in structure from the rest on the dorsal surface. On the under surface from 33 to 40 were differentiated, and showed a glandular structure, while the band representing the tubercula pubertatis extended distinctly along the ventral surface of 35, 36, 37, 38.

This description of the external characters shows the worm to be a decided Lumbricus, tested by Dr. Benham's definition in "An Attempt to Classify Earthworms"; but it differs from every one of our British species, especially in the backward position and inconspicuous nature of the clitellum. I am unable to refer it definitely to any of the European species, and propose that for the present it should be known as *Lumbricus rubescens* (Temp.), thus retaining the two names from Templeton's synonyms which are most appropriate to what I regard as the species intended by him.

I may add that I have recently found one or two other earthworms in Yorkshire which have not yet been recorded as British, and will form interesting additions to our Annelid fauna.

Idle, near Bradford, July 15. HILDERIC FRIEND.

Copepoda as an Article of Food.

DURING recent years a good deal has been said amongst marine zoologists of the use, as a food supply, that might be made of the enormous numbers of Copepoda that swarm in the surface-waters of the sea, and the Prince of Monaco has pointed out the value this widely-distributed nutritious matter might have to shipwrecked sailors; but I am not aware that anyone has yet actually made the experiment of cooking and eating Copepoda, so the following record may be of some interest.

While townetting during the last few days about the North Cape, we have had some large hauls of Copepoda; and it occurred to us last night, while watching the midnight sun off the entrance to the Lyngen Fjord, that one gathering might be spared from the preserving bottle and devoted to the saucepan. We put out one of the smaller townets ($3\frac{1}{2}$ feet long, mouth 1 foot in diameter) from 11.40 p.m. to midnight, the ship going dead slow, and traversing in all, say, a mile and a half during the 20 minutes. The net when hauled in contained about three tablespoonfuls of a large red Copepod (*Calanus finmarchicus*, I think), apparently a pure gathering—what Haeckel would call a monotonic plankton. We conveyed our material at once to the galley, washed it in a fine colander, boiled it for a few minutes with butter, salt, and pepper, poured it into a dish, covered it with a thin layer of melted butter, set it in ice to cool and stiffen, had it this morning for breakfast on thin bread-and-butter, and found it most excellent. The taste is less pronounced than that of shrimps, and has more the flavour of lobster. Our 20 minutes' haul of the small net through a mile or two of sea made, when cooked in butter, a dishful which was shared by eight people, and would probably have formed, with biscuit or bread, a nourishing meal for one person. It would apparently, in these seas, be easy to gather very large quantities, which might be preserved in tins or dishes, like potted shrimps.

W. A. HERDMAN.

S.Y. *Argo*, Tromsö, Norway, July 13.

Are Seedlings of *Hemerocallis fulva* specially Variable?

I SHALL be grateful to any of your readers who will write and let me know their experiences as to the variability of seedlings of *Hemerocallis fulva*, or who will raise it from seed in fair quantity, and kindly communicate to me their results, which shall be duly acknowledged.

My reason is this: there is in the formation of the pollen in this plant a peculiarity which, according to Weismann's views, should lead to exceptional variability in the seedlings; but, so far as I know, we have no evidence on the subject.

MARCUS M. HARTOG.

Royal University, Dublin, July 9.

The Green Sandpiper.

ON Sunday last, July 12, I saw flying round a large pool in Essex, a specimen of the *green sandpiper*. It flew leisurely round the pool, and seemed as if it were not far from its summer home. I think, therefore, that the bird must be nesting in the county, and probably in the neighbourhood.

Can any of your correspondents inform me whether the nest has been found anywhere, in recent years, in England?

ARGYLL.

Argyll Lodge, Kensington, July 17.

LIQUIDS AND GASES.[1]

ALMOST exactly twenty years ago, on June 2, 1871, Dr. Andrews, of Belfast, delivered a lecture to the members of the Royal Institution in this hall, on "The Continuity of the Gaseous and the Liquid States of Matter." He showed in that lecture an experiment which I had best describe in his own words:—

"Take, for example, a given volume of carbonic acid at 50° C., or at a higher temperature, and expose it to increasing pressure till 150 atmospheres have been reached. In the process, its volume will steadily diminish as the pressure augments; and no sudden diminution of volume, without the application of external pressure, will occur at any stage of it. When the full pressure has been applied, let the temperature be allowed to fall, until the carbonic acid has reached the ordinary temperature of the atmosphere. During the whole of this operation, no break of continuity has occurred. It begins with a gas, and by a series of gradual changes, presenting nowhere any abrupt alteration of volume, or sudden evolution of heat, it ends with a liquid.

[1] Lecture delivered by Prof. W. Ramsay, F.R.S., at the Royal Institution, on Friday, May 8.

"For convenience, the process has been divided into two stages—the compression of the carbonic acid, and its subsequent cooling. But these operations might have been performed simultaneously, if care were taken so to arrange the application of the pressure and the rate of cooling, that the pressure should not be less than 76 atmospheres when the carbonic acid had cooled to 31°."

I am able, through the kindness of Dr. Letts, Dr. Andrews' successor at Belfast, to show you this experiment, with the identical piece of apparatus used on the occasion of the lecture twenty years ago.

I must ask you to spend some time to-night in considering this remarkable behaviour; and, in order to obtain a correct idea of what occurs, it is well to begin with a study of gases, not, as in the case you have just seen, exposed to high pressures, but under pressures not differing greatly from that of the atmosphere, and at temperatures which can be exactly regulated and measured. To many here to-night, such a study is unnecessary, owing to its familiarity; but I will ask such of my audience to excuse me, in order that I may tell my story from the beginning.

Generally speaking, a gas, when compressed, decreases in volume to an amount equal to that by which its pressure is raised, provided its temperature be kept constant. This was discovered by Robert Boyle in 1660; in 1661 he presented to the Royal Society a Latin translation of his book, "Touching the Spring of the Air and its Effects." His words are:—

"'Tis evident, that as common air, when reduced to half its natural extent, obtained a spring about twice as forcible as it had before; so the air, being thus compressed, being further crowded into half this narrow room, obtained a spring as strong again as that it last had, and consequently four times as strong as that of common air."

To illustrate this, and to show how such relations may be expressed by a curve, I will ask your attention to this model. We have a piston, fitting a long horizontal glass tube. It confines air under the pressure of the atmosphere—that is, some 15 pounds on each square inch of area of the piston. The pressure is supposed to be registered by the height of the liquid in the vertical tube. On increasing the volume of the air, so as to double it, the pressure is decreased to half its original amount. On decreasing the volume to half its original amount, the pressure is doubled. On again halving, the pressure is again doubled. Thus you see a curve may be traced, in which the relation of volume to pressure is exhibited. Such a curve, it may be remarked incidentally, is termed an hyperbola.

We can repeat Boyle's experiment by pouring mercury into the open limb of this tube containing a measured amount of air; on causing the level of the mercury in the open limb to stand 30 inches (that is, the height of the barometer) higher in the open limb than the closed limb, the pressure of the atmosphere is doubled, and the volume is halved. And on trebling the pressure of the atmosphere the volume is reduced to one-third of its original amount; and, on adding other 30 inches of mercury, the volume of the air is now one-quarter of that which it originally occupied.

It must be remembered that here the temperature is kept constant; that it is the temperature of the surrounding atmosphere.

Let us next examine the behaviour of a gas when its temperature is altered, when it becomes hotter. This tube contains a gas—air—confined at atmospheric pressure by mercury, in a tube surrounded by a jacket or mantle of glass, and the vapour of boiling water can be blown into the space between the mantle and the tube containing the air, so as to heat the tube to 100°, the temperature of the steam. The temperature of the room is 17° C., and the gas occupies 290 divisions of the scale. On blowing in steam, the gas expands, and on again equalizing pressure, it

stands at 373 divisions of the scale. The gas has thus expanded from 290 to 373 divisions, *i.e.* its volume has increased by 83 divisions; and the temperature has risen from 17° to 100°, *i.e.* through 83°. This law of the expansion of gases was discovered almost simultaneously by Dalton and Gay-Lussac in 1801; it usually goes by the name of Gay-Lussac's law. Now, if we do not allow the volume of the gas to increase, we shall find that the pressure will increase, in the same proportion that the volume would have increased had the gas been allowed to expand, the pressure having been kept constant. To decrease the volume of the gas, then, according to Boyle's law, will require a higher initial pressure; and if we were to represent the results by a curve, we should get an hyperbola, as before, but one lying higher as regards pressures. And so we should get a set of hyperbolas for higher and higher temperatures.

We have experimented up to the present with air—a mixture of two gases, oxygen and nitrogen; and the boiling-points of both of these elements lie at very low temperatures: – 184° and – 193°·1 respectively. The ordinary atmospheric temperature lies a long way above the boiling-points of liquid oxygen and liquid nitrogen at the ordinary atmospheric pressure. But it is open to us to study a gas, which, at the ordinary atmospheric temperature and pressure, exists in the liquid state; and for this purpose I shall choose water-gas. In order that it may be a gas at ordinary atmospheric pressure, however, we must heat it to a temperature above 100° C., its boiling-point. This tube contains water-gas at a temperature of 105° C.; it is under ordinary pressure, for the mercury columns are at the same level in both the tubes and in this reservoir, which communicates with the lower end of the tube by means of the india-rubber tubing. The temperature 105° is maintained by the vapour of chlorobenzene, boiling in the bulb sealed to the jacket, at a pressure lower than that of the atmosphere.

Let us now examine the effect of increasing pressure. On raising the reservoir, the volume of the gas is diminished, as usual; and nearly in the ratio given by Boyle's law; that is, the volume decreases in the same proportion as the pressure increases. But a change is soon observed; the pressure soon ceases to rise; the distance between the mercury in the reservoir and that in the tube remains constant, and the gas is now condensing to liquid. The pressure continues constant during this change; and it is only when all the water-gas has condensed to liquid water that the pressure again rises. After all gas is condensed, an enormous increase of pressure is necessary to cause any measurable decrease in volume, for liquid water scarcely yields to pressure, and in such a tube as this, no measurements could be attempted with success.

Representing this diagrammatically, the right-hand part of the curve represents the compression of the gas; and the curve is, as before, nearly a hyperbola. Then comes a break, and great decrease in volume occurs without rise of pressure, represented by a horizontal line; the substance in the tube here consists of water-gas in presence of water; the vertical, or nearly vertical line represents the sudden and great rise of pressure, where liquid water is being slightly compressed. The pressure registered by the horizontal line is termed the "vapour-pressure" of water. If, now, the temperature were raised to 110°, we should have a greater initial volume for the water-gas; it is compressible by rise of the mercury as before, the relation of pressure to volume being, as before, represented on the diagram as an approximate hyperbola; and as before, condensation occurs when volume is sufficiently reduced, but this time at a higher pressure. We have again a horizontal portion, representing the pressure of water-gas at 110° in contact with liquid water; again, a sharp angle where all gaseous water is condensed, and again a very steep curve, almost a straight line, representing the slight decrease of volume of water produced by a great increase of pressure. And we should have similar lines for 120°, 130°, 140°, 150°, and for all temperatures within certain limits. Such lines are called isothermal lines, or shortly "isothermals," or lines of equal temperature, and represent the relations of pressure to volume for different temperatures.

Dr. Andrews made similar measurements of the relations between the pressures and volumes of carbon dioxide, at pressures much higher than those I have shown you for water. But I prefer to speak to you about similar results obtained by Prof. Sydney Young and myself with ether, because Dr. Andrews was unable to work with carbon dioxide free from air, and that influenced his results. For example, you see that the meeting-points of his hyperbolic curves with the straight lines of vapour-pressures are curves, and not angles; that is caused by the presence of about 1 part of air in 500 parts of carbon dioxide; also the condensation of gas was not perfect, for he obtained curves at the points of change from a mixture of liquid and gas to liquid. We, however, were more easily able to fill a tube with ether free from air, and you will notice that the points I have referred to are angles, not curves.

Let me first direct your attention to the shapes of the curves in the diagram. As the temperature rises, the vapour-pressure lines lie at higher and higher pressures, and the lines themselves become shorter and shorter. And finally, at the temperature 31° for carbon dioxide, and at 195° for ether, there ceases to be a horizontal portion at all; or rather, the curve touches the horizontal at one point in its course. That point corresponds to a definite temperature, 195° for ether; to a definite pressure, 27 metres of mercury, or 35·6 atmospheres; and to a definite volume, 4·06 cubic centimetres per gram of ether. At that point the ether is not liquid, and it is not gas; it is a homogeneous substance. At that temperature ether has the appearance of a blue mist; the striæ mentioned by Dr. Andrews, and by other observers, are the result of unequal heating, one portion of the substance being liquid, and another gas. You see the appearance of this state on the screen.

When a gas is compressed, it is heated. Work is done on the gas, and its temperature rises. If I compress the air in this syringe forcibly, its temperature rises so high that I can set a piece of tinder on fire, and by its help explode a little gunpowder. If the ether at its critical point be compressed by screwing in the screw, it is somewhat warmed, and the blue cloud disappears. Conversely, if it is expanded a little by unscrewing the screw, and increasing its volume, it is cooled, and a dense mist is seen, accompanied by a shower of ether rain. This is seen as a black fog on the screen.

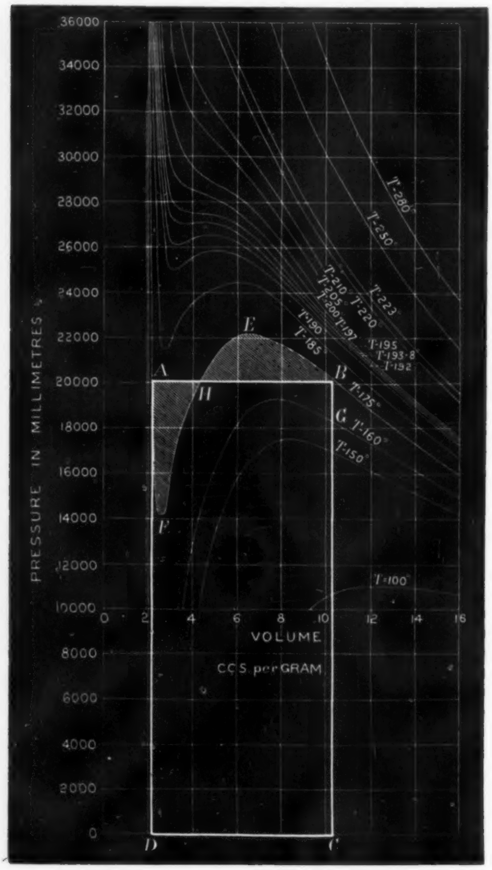
I wish also to direct your attention to what happens if the volume given to the ether is greater than the critical volume—on increasing the volume, you see that it boils away and evaporates completely; and also what happens if the volume be somewhat less than the critical volume—it then expands as liquid, and completely fills the tube. It is only at the critical volume and temperature that the ether exists in the state of blue cloud, and has its critical pressure. If the volume be too great, the pressure is below the critical pressure; if too small, the pressure is higher than the critical pressure.

Still one more point before we dismiss this experiment. At a temperature some degrees below the critical temperature, the meniscus, *i.e.* the surface of the liquid, is curved. It has a skin on its surface; its molecules, as Lord Rayleigh has recently explained in this room, attract one another, and it exhibits surface-tension. Raise the temperature, and the meniscus grows flatter; raise it further, and it is nearly flat, and almost invisible; at the critical temperature it disappears, having first become quite flat. Surface-tension, therefore, disappears at the critical point.

A liquid would no longer rise in a narrow capillary tube; it would stand at the same level outside and inside.

It was suggested by Prof. James Thomson, and by Prof. Clausius about the same time, that if the ideal state of things were to exist, the passage from the liquid to the gaseous state should be a continuous one, not merely at and above the critical point, but below that temperature. And it was suggested that the curves, shown in the figure, instead of breaking into the straight line of vapour-pressure, should continue sinuously. Let us see what this conception would involve.

On decreasing the volume of a gas, it should not liquefy at the point marked B on the diagram, but should



still decrease in volume on increase of pressure. This decrease should continue until the point E is reached. The anomalous state of matters should then occur, that a decrease in volume should be accompanied by a decrease of pressure. In order to lessen volume, the gas must be exposed to a continually diminishing pressure. But such a condition of matter is of its nature unstable, and has never been realized. After volume has been decreased to a certain point, F, decrease of volume is again attended by increase of pressure, and the last part of the curve is continuous with the realizable curve representing the compression of the liquid, above D.

Dr. Sydney Young and I succeeded, by a method which I shall briefly describe, in mapping the actual position of the unrealizable portions of the curve. They have the form pictured in this figure. The rise from the gaseous state is a gradual one; but the fall from the liquid state is abrupt.

Consider the volume 14 cubic centimetres per gram on the figure. The equi-volume vertical line cuts the isothermal lines for the temperatures 175°, 180°, 185°, 190°, and so on, at certain definite pressures, which may be read from a properly-constructed diagram. We can map the course of lines of equal volume, of which the instance given is one, using temperatures as ordinates and pressures as abscissæ. We can thus find the relations of temperature to pressure for certain definite volumes, which we may select to suit our convenience—say, 2 c.c. per gram; 3, 4, 5, 6, and so on. Now, all such lines are straight—that is, the relation of pressure to temperature, at constant volume, is one of the simplest; pressure is a linear function of temperature. Expressed mathematically—

$$p = bt - a,$$

where b and a are constants, depending on the volume chosen, and varying with each volume. But a straight line may be extrapolated without error; and so, having found values for a and b for such a volume as 6 c.c. per gram, by help of experiments at temperatures higher than 195°, it is possible by extrapolation to obtain the pressures corresponding to temperatures below the critical point 195° by simple means. But below that temperature the substance at volume 6 is in practice partly liquid and partly gas. Yet it is possible by such means to ascertain the relations of pressure to temperature for the *unrealizable portion* of the state of a liquid—that is, we can deduce the pressure and temperature corresponding to a continuous change from liquid to gas. And in this manner the sinuous lines on the figure have been constructed.

It is possible to realize experimentally certain portions of such continuous curves. If we condense all gaseous ether, and, when the tube is completely filled with liquid, carefully reduce pressure, the pressure may be lowered considerably below the vapour-pressure corresponding to the temperature of ebullition, without any change further than the slight expansion of the liquid resulting from the reduction of pressure—an expansion too small to be seen with this apparatus. But on still further reducing pressure, sudden ebullition occurs, and a portion of the liquid suddenly changes into gas, while the pressure rises quickly to the vapour-pressure corresponding to the temperature. If we are successful in expelling all air or gas from the ether in filling the tube, a considerable portion of this curve can be experimentally realized.

The first notice of this appearance, or rather of one owing its existence to a precisely similar cause, is due to Hooke, the celebrated contemporary of Boyle. It is noted in the account of the proceedings of the Royal Society on November 6, 1672, that "Mr. Hooke read a discourse of his, containing his thoughts of the experiment of the quicksilver's standing top-full, and far above the height of 29 inches; together with some experiments made by him, in order to determine the cause of this strange phenomenon. He was ordered to prepare those experiments for the view of the Society." And on November 13 "the experiment for the high suspension of quicksilver being called for, it was found that it had failed. It was ordered that thicker glasses should be provided for the next meeting."

There can be no doubt that this behaviour is caused by the attraction of the molecules of the liquid for each other. And if the temperature be sufficiently low, the pressure may be so reduced that it becomes negative—that is, until the liquid is exposed to a strain or pull, as is the mercury. This has been experimentally realized by M. Berthelot and by Mr. Worthington, the latter of whom has succeeded in straining alcohol at the ordinary tem-

perature with a pull equivalent to a negative pressure of 25 atmospheres, by completely filling a bulb with alcohol, and then cooling it. The alcohol in contracting strains the bulb inwards; and finally, when the tension becomes very great, parts from the glass with a sharp "click."

To realize a portion of the other bend of the curve, an experiment has been devised by Mr. John Aitken. It is as follows:—If air—that is, space, for the air plays a secondary part—saturated with moisture be cooled, the moisture will not deposit unless there are dust-particles on which condensation can take place. It is not at first evident how this corresponds to the compressing of a gas without condensation. But a glance at the figure will render the matter plain. Consider the isothermal 175° for ether, at the point marked A. If it were possible to lower the temperature to 160°, without condensation, keeping volume constant, pressure would fall, and the gas would then be in the state represented on the isothermal line 160°, at G: that is, it would be in the same condition as if it had been compressed without condensation.

You saw that a gas, or a liquid, is heated by compression; a piece of tinder was set on fire by the heat evolved on compressing air. You saw that condensation of ether was brought about by diminution of pressure—that is, it was cooled. Now, if air be suddenly expanded, it will do work against atmospheric pressure, and will cool itself. This globe contains air; but the air has been filtered carefully through cotton-wool, with the object of excluding dust-particles. It is saturated with moisture. On taking a stroke of the pump, so as to exhaust the air in the globe, no change is evident; no condensation has occurred, although the air has been so cooled that the moisture should condense, were it possible. On repeating the operation with the same globe, after admitting dusty air—ordinary air from this room—a slight fog is produced, and, owing to the light behind, a circular rainbow is seen; a slight shower of rain has taken place. There are comparatively few dust particles, because only a little dusty air has been admitted. On again repeating, the fog is denser; there are more particles on which moisture may condense.

One point more, and I have done. Work is measured by the distance or height through which a weight can be raised against the force of gravity. The British unit of work is a foot-pound—that is, a pound raised through one foot; that of the metric system is one gram raised through one centimetre. If a pound be raised through two feet, twice as much work is done as that of raising a pound through one foot, and an amount equal to that of raising two pounds through one foot. The measure of work is therefore the weight multiplied by the distance through which it is raised. When a gas expands against pressure, it does work. The gas may be supposed to be confined in a vertical tube, and to propel a piston upwards, against the pressure of the atmosphere. If such a tube has a sectional area of one square centimetre, the gas in expanding a centimetre up the tube lifts a weight of nearly 1000 grams through one centimetre; for the pressure of the atmosphere on a square centimetre of surface is nearly 1000 grams—that is, it does 1000 units of work, or ergs. So the work done by a gas in expanding is measured by the change of volume multiplied by the pressure. On the figure, the change of volume is measured horizontally, the change of pressure vertically. Hence the work done is equivalent to the area ABCD on the figure.

If liquid, as it exists at A, change to gas as it exists at B, the substance changes its volume, and may be made to do work. This is familiar in the steam-engine, where work is done by water, expanding to steam and so increasing its volume. The pressure does not alter during this change of volume, if sufficient heat be supplied, hence the work done during such a change is given by the rectangular area.

Suppose that a man is conveying a trunk up to the first story of a house, he may do it in two (or, perhaps, a greater number of) ways. He may put a ladder up to the drawing-room window, shoulder his trunk, and deposit it directly on the first floor. Or he may go down the area stairs, pass through the kitchen, up the kitchen stairs, up the first flight, up the second flight, and down again to the first story. The end result is the same; and he does the same amount of work in both cases, so far as conveying the weight to a given height is concerned; because in going down-stairs he has actually allowed work to be done on him, by the descent of the weight.

Now, the liquid in expanding to gas begins at a definite volume; it evaporates gradually to gas without altering pressure, heat being, of course, communicated to it during the change, else it would cool itself; and it finally ends as gas. It increases its volume by a definite amount at a definite pressure, and so does a definite amount of work; this work might be utilized in driving an engine.

But if it pass continuously from liquid to gas, the starting-point and the end point are both the same as before. An equal amount of work has been done. But it has been done by going down the area stair, as it were, and over the round I described before.

It is clear that a less amount of work has been done on the left-hand side of the figure than was done before; and a greater amount on the right-hand side; and if I have made my meaning clear, you will see that as much less has been done on the one side as more has been done on the other—that is, that the area of the figure BEH must be equal to that of the figure AFH. Dr. Young and I have tried this experimentally—that is, by measuring the calculated areas; and we found them to be equal.

This can be shown to you easily by a simple device—namely, taking them out and weighing them. As this diagram is an exact representation of the results of our experiments with ether, the device can be put in practice. We can detach these areas which are cut out in tin, and place one in each of this pair of scales, and they balance. The fact that a number of areas thus measured gave the theoretical results of itself furnishes a strong support of the justice of the conclusions we drew as regards the forms of these curves.

To attempt to explain the reasons of this behaviour would take more time than can be given to-night; moreover, to tell the truth, we do not know them. But we have at least partial knowledge; and we may hope that investigations at present being carried out by Prof. Tait may give us a clear idea of the nature of the matter, and of the forces which act on it, and with which it acts, during the continuous change from gas to liquid.

EXPERIMENTAL RESEARCHES ON MECHANICAL FLIGHT.

THE following is a translation of a communication made by Prof. S. P. Langley to the Paris Academy of Sciences on July 13:—

I have been carrying out some researches intimately connected with the subject of mechanical flight, the results of which appear to me to be worthy of attention. They will be published shortly in detail in a memoir. Meanwhile I wish to state the principal conclusions arrived at.

In this memoir I do not pretend to develop an art of mechanical flight; but I demonstrate that, with motors having the same weights as those actually constructed, we possess at present the necessary force for sustaining, with very rapid motion, heavy bodies in the air; for example, inclined planes more than a thousand times denser than the medium in which they move.

Further, from the point of view of these experiments and

also of the theory underlying them, it appears to be demonstrated that if, in an aërial movement, we have a plane of determined dimensions and weight, inclined at such angles and moving with such velocities that it is always exactly sustained in horizontal flight, the more the velocity is augmented the greater is the force necessary to diminish the sustaining power. It follows that there will be increasing economy of force for each augmentation of velocity, up to a certain limit which the experiments have not yet determined. This assertion, which I make here with the brevity necessary in this *résumé*, calls for a more ample demonstration, and receives it in the memoir that I have mentioned.

The experiments which I have made during the last four years have been executed with an apparatus having revolving arms about 20 metres in diameter, put in movement by a 10 horse-power steam-engine. They are chiefly as follows:—

(1) To compare the movements of planes or systems of planes, the weights, surface, form, and variable arrangements, the whole being always in a horizontal position, but disposed in such a manner that it could fall freely.

(2) To determine the work necessary to move such planes or systems of planes, when they are inclined, and possess velocities sufficient for them to be sustained by the reaction of the air in all the conditions of free horizontal flight.

(3) To examine the motions of aërostats provided with their own motors, and various other analogous questions that I shall not mention here.

As a specific example of the first category of experiments which have been carried out, let us take a horizontal plane, loaded (by its own weight) with 464 grams, having a length 0·914 metre, a width 0·102 metre, a thickness 2 mm., and a density about 1900 times greater than that of the surrounding air, acted on in the direction of its length by a horizontal force, but able to fall freely.

The first line below gives the horizontal velocities in metres per second; the second the time that the body took to fall in air from a constant height of 1·22 metres, the time of fall in a vacuum being 0·50 second.

Horizontal velocities ...	0m.,	5m.,	10m.,	15m.,	20m.
Time taken to fall from a constant height of 1·22 metres	0·53s.,	0·61s.,	0·75s.,	1·05s.,	2·00s.

When the experiment is made under the best conditions it is striking, because, the plane having no inclination, there is no vertical component of apparent pressure to prolong the time of fall; and yet, although the specific gravity is in this more than 1900 times that of the air, and although the body is quite free to fall, it descends very slowly, as if its weight were diminished a great number of times. What is more, the increase in the time of fall is even greater than the acceleration of the lateral movement.

The same plane, under the same conditions, except that it was moved in the direction of its length, gave analogous but much more marked results; and some observations of the same kind have been made in numerous experiments with other planes, and under more varied conditions.

From that which precedes, the general conclusion may be deduced that the time of fall of a given body in air, whatever may be its weight, may be indefinitely prolonged by lateral motion, and this result indicates the account that ought to be taken of the inertia of air, in aërial locomotion, a property which, if it has not been neglected in this case, has certainly not received up to the present the attention that is due to it. By this (and also in consequence of that which follows) we have established the necessity of examining more attentively the practical possibility of an art very admissible in theory —that of causing heavy and conveniently disposed bodies to slide or, if I may say so, to travel in air.

In order to indicate by another specific example the nature of the data obtained in the second category of my experiments, I will cite the results found with the same plane, but carrying a weight of 500 grams, that is 5380 grams per square metre, inclined at different angles, and moving in the direction of its length. It is entirely free to rise under the pressure of the air, as in the first example it was free to fall; but when it has left its support, the velocity is regulated in such a manner that it will always be subjected to a horizontal motion.

The first column of the following table gives the angle (a) with the horizon; the second the corresponding velocity (V) of *planement*—that is, the velocity which is exactly sufficient to sustain the plane in horizontal movement, when the reaction of the air causes it to rise from its support; the third column indicates in grams the resistances to the movement forward for the corresponding velocities—a resistance that is shown by a dynamometer. These three columns only contain the data of the same experiment. The fourth column shows the product of the values indicated in the second and third—that is to say, the work T, in kilogram-metres per second, which has overcome the resistance. Finally, the fifth column, P, designates the weight in kilograms of a system of such planes that a 1 horse-power engine ought to cause to advance horizontally with the velocity V and at the angle of inclination a.

	V	R	$T = \frac{VR}{1000}$	$P = \frac{500 \times 4554}{T \times 60 \times 1000}$
45	11·2	500	5·6	6·8
30	10·6	275	2·9	13·0
15	11·2	128	1·4	26·5
10	12·4	88	1·1	34·8
5	15·2	45	0·7	55·5
2	20·0	20	0·4	95·0

As to the values given in the last column, it is necessary to add that my experiments demonstrate that, in rapid flight, one may suppose such planes to have very small interstices, without diminishing sensibly the power of support of any of them.

It is also necessary to remark that the considerable weights given here to the planes have only the object of facilitating the quantitative experiments. I have found that surfaces approximately plane, and weighing ten times less, are sufficiently strong to be employed in flight, such as has been actually obtained, so that in the last case more than 85 kilograms are disposable for motors and other accessories. As a matter of fact, complete motors weighing less than five kilograms per horse-power have recently been constructed.

Although I have made use of planes for my quantitative experiments, I do not regard this form of surface as that which gives the best results. I think, therefore, that the weights I have given in the last column may be considered as less than those that could be transported with the corresponding velocities, if in free flight one is able to guide the movement in such a manner as to assure horizontal locomotion—an essential condition to the economical employment of the power at our disposal.

The execution of these conditions, as of those that impose the practical necessity of ascending and descending with safety, belongs more to the art of which I have spoken than to my subject.

The points that I have endeavoured to demonstrate in the memoir in question are:—

(1) That the force requisite to sustain inclined planes in horizontal aërial locomotion diminishes, instead of increasing, when the velocity is augmented; and that up to very high velocities—a proposition the complete experimental demonstration of which will be given in my memoir; but I hope that its apparent improbability

will be diminished by the examination of the preceding examples.

(2) That the work necessary to sustain in high velocity the weights of an apparatus composed of planes and a motor may be produced by motors so light as those that have actually been constructed, provided that care is taken to conveniently direct the apparatus in free flight; with other conclusions of an analogous character.

I hope soon to have the honour of submitting a more complete account of the experiments to the Academy.

ON THE SOLID AND LIQUID PARTICLES IN CLOUDS.[1]

IN this paper are given the results of some observations made while on the Rigi in May last, on the solid and liquid particles in clouds. It was noticed, when making observations on the number of dust particles in the atmosphere, that when the top of the mountain was in cloud, the number of particles varied greatly in short intervals; while previous experience had shown that at elevated stations the number was fairly constant for long periods. In order to investigate the case of this want of uniformity in the impurity of clouded air, extreme conditions were selected, and the air tested in cloud and in the clear air outside of it. When this was done the clouded air was found to have always more dust in it than the air outside. Its humidity was of course also greater. The relative amount of dust in pure and in clouded air varied greatly. Some parts of the cloud had only about double the number of particles there were in the clear air, while in other parts the proportion was much greater. The best example tested occurred on the 25th of the month, when there were observed 700 particles per c.c. in the clear air, while the number in cloud went up to over 3000, and in one cloud to 4200 particles per c.c. These observations were taken on the top of the mountain while the clouds were passing over it; the readings being taken in the cloud and again when it had passed and was replaced by clear air.

These observations at once showed the cause of the variability in the number of dust-particles in the clouds. The dust acted as a kind of ear-mark, and showed that the air forming the clouds was impure valley air, which had forced its way up into the purer air above. This impure air had become more or less mixed with the purer upper air. Where little of the impure air had mixed with the upper air, the number of particles was not large, and the clouding slight; but where the valley air was greatly in excess, the number of particles was great, and the clouding dense. It should be noted here that all the clouds tested were cumulus. It is quite probable that the conditions in stratus and other clouds may be different.

During this visit to the Rigi there were a number of opportunities of investigating the water particles in clouds. The apparatus used was the small instrument described to the Society in May last. With this instrument the water particles in clouds can be easily seen, and the number falling on a given area counted. The results are similar to those already communicated to the Society from observations made in fogs during last winter. On observing with this instrument in clouds, the water particles were distinctly seen showering down, and the number falling on the micrometer easily counted. The number of drops falling was observed to vary greatly from time to time. At times so quickly did they fall that it was impossible to count the number that fell on only 1 sq. mm. The greatest rate actually counted was 60 drops per sq. mm. in 30 seconds, but for a few seconds the rate was much quicker. Though the quick falls seldom lasted long, yet 30 drops per sq. mm. per minute were frequently observed for a considerable time. The maximum rate of 60 per sq. mm. per half minute gives 12,000 drops per square centimetre per minute, or 77,400 drops per square inch per minute. This does seem to be an enormous number of drops to fall on so small an area in the time. These drops, however, are so extremely small they rapidly evaporate, more than two or three being seldom visible at the same time on one square of the micrometer. The denser the cloud the quicker was the rate of fall, and as the cloud thinned away the drops fell at longer intervals, and they diminished in size at the same time.

It was frequently observed when the mountain-top was in clouds, particularly if they were not very dense overhead, that the surfaces of all exposed objects were quite dry; not only the stones on the ground, which might have received heat from the earth, but also wooden seats, posts, &c., were all perfectly dry, and if wetted they soon dried. While everything was dry, the fog-counter showed that fine rain-drops were falling in immense numbers. From the fact that the air was packed full of these small drops of water, it might have been assumed that the air was saturated, and tests with properly-protected wet and dry bulb thermometers showed that it was saturated. A few observations were therefore made to explain this apparent contradiction of surfaces remaining dry while exposed to a continued shower of fine rain and surrounded by saturated air. The explanation was found to be, simply, radiant heat. Though the cloud may be so dense, it is impossible to see the sun or even a preponderance of light in one direction to indicate its position; yet, as a good deal of light penetrates under these conditions, it therefore seemed possible some heat might do so also. A thermometer with black bulb *in vacuo* showed that a considerable amount of heat penetrated the clouds under the conditions, as it rose 40° to 50° above the temperature of the air while the observations were being made. This radiant heat is absorbed by all exposed surfaces and heats them, while they in turn heat the air in contact with them, and the fine drops of water are either evaporated in this hot layer of air or after they come in contact with the heated surfaces. Other observations made on Pilatus pointed to the same conclusion. All large objects, such as seats, posts, &c., were quite dry in cloud when there was any radiation; while small objects, such as pins, fine threads, &c., were covered with beads of water. The large surfaces being more heated by radiation than small ones, when surrounded by air, these surfaces evaporate the drops falling on them, while the small ones, being kept cool by the passing air, are unable to keep themselves dry.

The observations made with the fog-counter point to the conclusion that the density or thickness of a cloud depends more on the number of water particles than on the number of dust particles in it. The number of the dust particles in the clouds varied too much and too quickly to enable any conclusion to be drawn from observations made in clouds themselves. However, on comparing the thickness of a cloud on the Rigi and a fog at low level, when the number of water-drops was about the same, it is found that the fog, though thicker, was not greatly so, although there were only a few thousand dust-particles per c.c. in the cloud, while there were about 50,000 in the fog.

The observations with the fog-counter show that, whenever a cloud is formed, it at once begins to rain, and the small drops fall into the drier air underneath, where they are evaporated, the distance to which they will fall depending on their size and the dryness of the air. It is thought that much of the dissolving of clouds is brought about in this way.

[1] Abstract of Paper read before the Royal Society, Edinburgh, on July 6, by John Aitken, F.R.S. Communicated by permission of the Council of the Society.

OLD STANDARDS.

BY a curious accident it has just been discovered that the standard yard and certain other measures and weights which were supposed to have been lost when the Houses of Parliament were destroyed by fire in 1834 are still in existence. The following account of the matter is condensed from a statement in the *Times*. A reference to the contemporary records shows that after the fire the standard bars of 1758 and 1760 were both found among the ruins, "but they were too much injured to indicate the measure of a yard which had been marked upon them." The principal injury to both of the standards was the loss of the left-hand gold stud, but whether this was caused by the action of the flames or otherwise is not known. When the Palace of Westminster was rebuilt the two bars were deposited in the Journal Office, and from that time, until the other day, they seem to have been wholly lost sight of. About a fortnight ago it happened to be stated in the lobby that one of the duties of the Speaker was to inspect once in every twenty years the standards immured in the sill of the Lower Waiting Hall. Inquiries at the Standards Department of the Board of Trade elicited the fact that, so far from any statutory requirement being imposed upon the Speaker in the direction indicated, Section 35 of the Weights and Measures Act, 1878, which provides for the care and restoration of the Parliamentary copies of the Imperial standards, specially exempts the walled-up copy from periodical inspection and comparison. It was found, however, that in 1871 Speaker Denison took cognizance of the standards; and this fact was brought to the Speaker's notice. While inquiries were being made as to Speaker Denison's inspection, an official in the Journal Office mentioned that when the contents of that office were recently being transferred to the new wing he had observed among the lumber some old weights and measures. These proved to be the missing standards. On Tuesday last they were examined by Mr. Chaney, the Superintendent of Weights and Measures; and on Wednesday the Speaker was to visit the Journal Office for the purpose of inspecting them.

The most important of the standards thus rescued from oblivion are the yard measures constructed by Bird in 1758 and 1760. The former was copied from a bar in the possession of the Royal Society, which was itself a copy of a standard preserved in the Tower; and the second was constructed under the directions of a Committee of the House of Commons from the 1758 standard. "Each of these two standard yards consisted of a solid brass bar 1·05 in. square in section and 39·73 in. long. Near each end of the upper surface gold pins or studs 0·1 in. in diameter were inserted, and points or dots were marked upon the gold to determine the length of the yard." The other standards in the custody of the Journal Office are two brass rods answering the description of the old Exchequer yard, and four weights supposed to be certain of the "copies, model, patterns, and multiples" ordered by the House on May 21, 1760, "to be locked up by the clerk and kept by him." The most important weight—the standard troy pound—is not amongst those now brought to light.

NOTES.

AT some little distance to the north and north-east of Cardiff lies a beautiful piece of hilly country, much frequented by pedestrians, and known as the Black Mountain or Black Forest district. It has not been found practicable by the Local Committee to arrange an official excursion to this district on the occasion of the visit of the British Association to Cardiff; but a project is now being unofficially forwarded for conducting small parties of not exceeding six visitors each to some of the choicest parts of this country, at a time so arranged as not to interfere with the sittings of the various Sections. Several local gentlemen, thoroughly familiar with the district, have offered to act as guides, and with fair weather most enjoyable excursions are to be anticipated. The country being essentially one for pedestrians, the excursions would take the form of an afternoon walk of from eight to twelve miles, with a further walk on the following day of from twenty-five to thirty miles. Any member of the British Association desirous of taking part in one of these excursions can obtain full particulars by applying to the Local Secretaries, 9 Bank Buildings, Cardiff, who will forward the applications to the promoters.

THE annual meeting of the French Association for the Advancement of the Sciences will be held at Marseilles, commencing on September 17. The special subject chosen for discussion in the Botanical Section is the best mode of arrangement and exhibition for different kinds of botanical collections, with the double purpose of the preservation of the specimens and the facilitating of study.

THE Technical and Recreative Institute established by the Goldsmiths' Company at New Cross was opened by the Prince of Wales on Wednesday. In addition to this Institute there are to be two Polytechnics south of the Thames, one in Battersea Park Road, the other in the Borough Road. The memorial stone of the one in Battersea was laid by the Prince of Wales on Monday.

PROF. M. W. HARRINGTON, the founder of the *American Meteorological Journal*, has been appointed Chief of the United States Weather Bureau, under the Department of Agriculture in Washington. Prof. Harrington was born in Illinois in 1848, and graduated at Michigan in 1868. In 1879 he was made Professor of Astronomy and Director of the Astronomical Observatory at Ann Arbor, Michigan. From a recent article by him, entitled "How could the Weather Service best promote Agriculture?" it appears likely that the energies of the new service will be devoted more to the interests of agriculture than to commerce, and that an attempt will be made to issue special weather predictions for the farmer, by means of the multiplication of local forecasting stations. There can be little doubt—seeing the large amount of funds under his control—that he will also still further advance the important work of international meteorology which has been so ably conducted by his predecessors.

THE half-yearly general meeting of the Scottish Meteorological Society was held in Edinburgh on Wednesday. The report from the Council of the Society was presented; and papers were read on certain relations of wind, pressure, and temperature at the Ben Nevis Observatories, by Dr. Buchan, and on influenza and weather of London in 1891, by Sir Arthur Mitchell and Dr. Buchan.

FROM the official record of the work done in the British Museum during 1890 it seems that there has been a serious decrease in the number of visitors. Special departments, however, have been used more than ever by students; and it is satisfactory to find that the zoological and geological collections in the Natural History Museum are being more generally appreciated.

GERMAN scientific papers record the death, on June 18, of Dr. Otto Tischler, well known as an archæologist of wide learning and sound judgment. He especially distinguished himself by his investigation of the burial-mounds of East Prussia. Dr. Tischler was forty-eight years of age.

PROF. A. RICCÒ, Director of the Catania Observatory, who has just returned from a visit to the volcano Stromboli, sends us the following notice of a recent eruption:—"On June 24, 45

minutes after noon (Rome mean time), the inhabitants of the Æolian Isles were alarmed by two strong shocks of earthquake, followed by two tremendous explosions of the volcano, which sent forth from four mouths a great quantity of smoke, cinders, incandescent blocks, and currents of lava that descended the mountain slopes to the sea. The sea, at the points where the lava entered it, steamed up, producing great noisy masses of vapour. The phenomena continued till July 1. Stromboli has now returned to its habitual state of moderate activity."

THE annual meeting of the Society for the Preservation of the Monuments of Ancient Egypt was held last week in the rooms of the Society of Antiquaries at Burlington House. Lord Wharncliffe, President, occupied the chair. The report stated that there was little to report of success attending the proceedings of the Society for the past year. Its energies had been directed principally to two points—the necessity for an official inspector or superintendent in Egypt, whose duty should be the care of the ancient monuments, and an endeavour to do something towards arresting the gradual destruction of the Great Temple at Karnak. Reports concerning a proposed scheme for barring the Nile below Philæ, to make a vast reservoir for purposes of irrigation, had appeared in the public papers from time to time, and recently various more definite communications had been received by the committee on the same subject. The result would be, it was acknowledged, to completely cover this beautiful island and temple with water. There had been some correspondence on this subject with the authorities in Egypt; but as nothing had as yet been decided as to any scheme of irrigation, and as a committee would be appointed to consider the whole question, it might be considered as suspended for the present, and the committee had thought it best to wait before taking any further action; but they would not lose sight of this important matter, and would oppose to the utmost of their power any engineering scheme which would involve injury or destruction to this world-renowned spot. General Donnelly moved the adoption of the report; and the motion was seconded by Sir Edmund Henderson, and agreed to. The committee for the coming year was then elected, and a discussion subsequently took place as to the proposed scheme for barring the Nile below Philæ, the opinion of the meeting being evidently strongly opposed to the adoption of any system of irrigation which should involve damage to the temple. Mr. J. Bryce, M.P., spoke of the wanton injury which was often inflicted on monuments in Egypt, and said that he thought it would be necessary, in dealing with that matter, to bring the question of jurisdiction to the attention of those from whom any system of inspection or care was to emanate. We may note that in answer to a question put by Mr. Bryce in the House of Commons on July 15, Sir J. Fergusson said that nothing definite had been settled as to the preservation of ancient monuments in Egypt; £E10,000 had been allotted in the Budget for the current year.

THE Pilot Chart of the North Atlantic Ocean for July contains a special account of a hurricane that moved along a track almost due north, about 500 miles east of Newfoundland on June 9 and 10, together with a chart of the conditions of barometer and wind between Newfoundland and Ireland, showing that the abnormal track was due to the approach of an anticyclone west of the British Isles. A supplement issued with the Pilot Chart illustrates the drift of every bottle paper returned to the United States Hydrographic Office since April 1889. There are 113 papers that contain the date of commencement and end of journey; the average number of miles that each bottle drifted is 869, and the average daily drift is 5·8 miles. This figure is rather below the true average rate per day, as any time the bottle lay upon the shore before discovery added to its time of drift.

M. PATOUILLARD has just returned from a scientific mission with which he was intrusted by the Minister of Public Instruction in France, an investigation of the mycological flora of Tunis, Carthage, and the adjacent regions.

IN one of the principal articles of the *Meteorologische Zeitschrift* for May, Herr R. Börnstein discusses the question of a connection between air-pressure and the hour angle of the moon, using as a basis the hourly observations of four German and Austrian stations. This investigation differs from the usual mode of treatment, as it takes no account of the moon's phases, or of its declination or distance from the earth, but only of the lunar day, and deals solely with atmospheric pressure. The results arrived at are: (1) that the existence of atmospheric tides is not plainly recognizable in the range of pressure; (2) at three of the stations the pressure exhibits a single oscillation during the lunar day. The maximum occurs at Hamburg and Berlin shortly before the setting of the moon, and at Vienna about the time of the lower culmination, while the minimum occurs at all stations near the time of the moon's rising.

WE have received vol. viii. of the *Anales de la Oficina Meteorologica Argentina*. It contains a summation of the records obtained at five different stations in the Republic during the years 1877–89. The organization of the Department appears to be now very complete, there being no less than twenty-eight stations fully equipped with ordinary and self-registering instruments.

REFERRING to a statement which has been publicly made, that the adoption of electric lighting in place of gas at the office of the Savings Bank Department of the General Post Office has been followed by a marked reduction in the amount of sick leave, the *Lancet* says it has good authority for believing that the statement in question is substantially correct. Although the time which has as yet elapsed—two years—since the introduction of the new illuminant has been insufficient for the collection of trustworthy statistics, our contemporary thinks there is every reason to believe that electric lighting will prove to be much more wholesome than ordinary gas flames. An electric lamp does not compete for the oxygen of the apartment in which it is placed, and this circumstance gives it a marked advantage over any open flame. It cannot, like some forms of gas-burner, be used to promote ventilation; but in ordinary situations its harmlessness is a much more important property.

METEOROLOGICAL observatories are generally ill adapted, by reason of dust and smoke, for observations on atmospheric electricity; and, with the view of inciting private individuals to such work, Herren Elster and Geitel, of Wolfenbüttel, have lately issued a *brochure* in which they indicate the ends to be sought and the instrumental means. Three things demand attention: first, systematic observation and measurement of electricity in the open air at different times in the day and in the seasons, humidity and air-temperature being determined at the same time; second, measurement of the fall of potential with a clear sky; and third, measurement of the fall of potential and its change of sign during rain, &c. The instruments and methods recommended are such as present little difficulty for private persons.

THE American National Geographic Society prints in the current number of its magazine a full and interesting account, by Israel C. Russell, of an expedition to Mount St. Elias, Alaska. The paper is illustrated by various excellent maps and diagrams.

THE Winchester College Natural History Society has just issued, under the title of "Geological Notes" (J. Wells, Winchester), a list of all the fossils as yet known from the chalk in the anticlinal of Winchester. The exact localities and zones are given; and, since the names appear not only to have been

carefully determined, but to be well up to date, this very modest pamphlet will prove as useful a guide to the collector as it is valuable to the stratigraphical geologist.

MESSRS. WOODALL, MINSHALL, AND CO., Oswestry, have issued "A Flora of Oswestry and District," by T. P. Diamond, Honorary Secretary of the Offa Field Club. It contains a list of plants in the neighbourhood of Oswestry, arranged according to their natural orders; and at the end there is an index, in which both the English and the Welsh names of the plants are given. Mr. Diamond calls attention to the fact that his "list of over 700 plants includes representatives of 90 out of the 101 natural orders in the flora of the United Kingdom."

THE United States Department of Agriculture is printing—in the series entitled "Contributions from the United States National Herbarium"—what promises to be a valuable manual of the plants of Western Texas, by John M. Coulter. This district is described as "one of the richest regions in plant display, containing a flora particularly interesting on account of the intermingling of Mexican species." The manual is being published in parts because the author hopes that their successive appearance may call forth additional information that may be embodied in a final supplement.

A SHEET dealing with the potato disease will shortly be issued by the Royal Agricultural Society of England. It was originally published by the Irish Land Commission, by whose permission it is being reproduced. In the text, by Mr. William Carruthers, F.R.S., all necessary information is given, and this is accompanied by coloured drawings illustrating various phases of the potato disease.

IN the July number of the *London and Middlesex Note-Book*, Mr. G. F. Lawrence says he recently obtained a drift implement of unusual form from the site of Mr. Peter Robinson's new premises in Oxford Street. The peculiarity consists of the curious curvature of one face of the implement compared with the flatness of the other side. He does not know of another like it, but suggests that, as attention is called to what may be a mere variation of an ordinary type, examples may be found in other collections. This specimen is of a somewhat ochreous colour, is lustrous and but slightly abraded or rolled, and it measures $5\frac{3}{16}$ inches long by 3 inches wide. The occurrence of drift-implements in Central London is rather unusual. Mr. Lawrence thinks twelve would be rather over than under the number known.

IN the current number of the Scientific Proceedings of the Royal Dublin Society (vol. vii. Part 2) Mr. E. W. L. Holt publishes a preliminary note on the fish obtained during the cruise of the s.s. *Fingal*, 1890, on the Society's survey of fishing grounds on the west coast of Ireland. Amongst the shore fishes, *Aphia pellucida*, Nardo, and *Crystallogobius nilssonii*, Düb. and Kor., are for the first time recorded from Irish waters. The second British specimen of *Arnoglossus grohmanni*, Bonap., is also recorded. From depths between 100 and 500 fathoms off Achill Head, *Pomatomus telescopium*, Risso, *Mora mediterranea*, Risso, and *Macrurus æqualis*, Gthr., are added to the British fauna; and a description is given of a new deep-sea eel, intermediate between Saurenchelys and Nettastoma, which has been named *Nettophichthys retropinnatus*, n. g. et sp. *Gadus esmarkii*, Nilsson, and *Macrurus rupestris*, Gunner, are added to the Irish fauna from similar depths, and *Argentina sphyræna*, Linn., from 52 to 80 fathoms. Amongst other fish recorded from depths exceeding 100 fathoms are *Chimæra monstrosa*, Linn., *Trigla lyra*, Linn., *Gadus argenteus*, Guich., *Phycis blennioides*, Brünn., *Haloporphyrus eques*, Gthr., *Macrurus cœlorhynchus*, Risso, *M. lævis*, Lowe, &c. A young Phycis is also recorded from 26 fathoms, and mention is made of the occurrence at the surface of a shoal of young *Gadus poutassou*, Risso, 34 miles from land.

HARDNESS is one of the most important properties of solid bodies; yet the measurement of it has not been very satisfactorily effected hitherto. Prof. Auerbach, of Jena, has recently described (*Repertorium für Physik*) an apparatus for the purpose, designed for transparent bodies. In it the spherical surface of a lens is pressed up by the short arm of a weighted lever against a small thick plate, on which the observer looks down through a microscope furnished with a micrometer, watching the effects of increasing pressure. Glass and rock crystal were observed. The author offers a theory of the subject, and tests it. A comparison of hardnesses with moduli of elasticity shows that, while the more elastic of those substances were also the harder, the hardness increases less than the elasticity.

FROM recent accounts it appears that the consumption of gas in Paris in 1890 exceeded that in 1880 by 26·2 per cent., while the number of consumers increased 56·8 per cent. The amount per consumer diminished 19·5 per cent., from 1642 to 1322 cubic metres. Electricity has evidently withdrawn many large consumers of gas. The same account states that in *three* years the number of arc and glow lamps has increased 140 and 170 per cent. respectively. The consumption of petroleum in France has increased 47 per cent in those ten years, while that of gas, in the whole of France, has grown 62 per cent.

A SERIES of addition compounds of aldehydes with hypophosphorous acid are described by M. Ville in the current number of the *Annales de Chimie et de Physique*. As is well known, aldehydes exhibit the characteristic property of uniting directly with many other substances, such as ammonia, hydrocyanic acid, acid sulphites, and hydroxylamine. Some time ago, it was shown by Fossek that trichloride of phosphorus was likewise capable of uniting directly with many aldehydes with production of liquid compounds decomposable by water. M. Ville now shows that a similar series of additive compounds are formed with hypophosphorous acid, and these compounds are of considerable importance as throwing more light upon the nature of this lower acid of phosphorus. Hypophosphorous acid, H_3PO_2, the acid derived from the as yet unisolated oxide P_2O, may be regarded as possessing the structure $\begin{array}{l} H \\ | \\ PO—OH. \\ | \\ H \end{array}$ By the direct action of aldehydes under the influence of a slight rise of temperature, two distinct classes of new compounds are obtained. When the aldehyde and hypophosphorous acid are allowed to react in the proportion of equal molecules, compounds of the type $\begin{array}{l} R—CH—OH \\ \quad\;\, | \\ \quad\;\, PO—OH \\ \quad\;\, | \\ \quad\;\, H \end{array}$ are obtained, where R may represent the radicle of any aldehyde. If, however, two molecular proportions of aldehyde are employed, compounds of the type $\begin{array}{l} R—CH—OH \\ \quad\;\, | \\ \quad\;\, PO—OH \\ \quad\;\, | \\ R—CH—OH \end{array}$ are formed. The aldehydes of the aromatic series lend themselves best to the formation of these compounds, those of the fatty series exhibiting a great tendency to the production of condensation products. The compound of the second type with benzoic aldehyde, $\begin{array}{l} C_6H_5—CH—OH \\ \qquad\;\; | \\ \qquad\;\; PO—OH, \\ \qquad\;\; | \\ C_6H_5—CH—OH \end{array}$ is obtained by digesting to-

gether for several hours upon a water-bath benzaldehyde and hypophosphorous acid in an atmosphere of carbon dioxide. Crystals of the new compound soon commence to separate, and rapidly permeate the whole liquid. On draining and washing, they are found to consist of colourless radiating groups of lamellæ. They are not very soluble in water, but dissolve more readily in organic solvents, best in methyl alcohol. The aqueous solution is strongly acid, decomposing carbonates readily, and forming crystalline salts with bases. Curiously, though, it exerts no reducing action upon solutions of copper sulphate or silver salts. In order to obtain the acid of the first type,

$$\begin{array}{l} C_6H_5\text{—CH—OH} \\ \quad\quad\quad | \\ \quad\quad\; \text{PO—OH,} \\ \quad\quad\quad | \\ \quad\quad\quad \text{H} \end{array}$$

it is best to employ an excess of hypophosphorous acid. In this case, instead of crystals of the acid of the second type separating, the whole forms a homogeneous liquid which remains unprecipitated by water. It contains the acid of the first type, and this latter is best isolated by precipitating the lead salt by the addition of lead acetate and decomposing the salt, suspended in water, by means of sulphuretted hydrogen. On concentration of the filtered solution, a syrup is obtained which eventually yields deliquescent crystals of the pure acid. The solution of this acid does not reduce copper sulphate, but readily precipitates metallic silver from silver nitrate. Many similar compounds with other aldehydes have also been prepared, and found to present analogous properties more or less modified by the specific nature of the particular aldehyde employed.

THE additions to the Zoological Society's Gardens during the past week include two Ruddy-headed Geese (*Bernicla rubidiceps* ♂ ♂) from the Falkland Islands, presented by Mr. F. E. Blaauw, C.M.Z.S.; a Smooth Snake (*Coronella lævis*), British, presented by Mr. W. H. B. Pain; two great Eagle Owls (*Bubo maximus*), European, deposited; six Eyed Lizards (*Lacerta ocellata*), two Four-lined Snakes (*Coluber quadrilineatus*), a Back-marked Snake (*Rhinechis scalaris*), South European, purchased; a Burrhel Wild Sheep (*Ovis burrhel* ♂), a Japanese Deer (*Cervus sika* ♀), a Bennett's Wallaby (*Halmaturus bennetti* ♀), two Night Herons (*Nycticorax griseus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

A CAUSE OF LUNAR LIBRATION.—A paper by Mr. S. E. Peal, "On a Possible Cause for Lunar Libration other than an Ellipsoidal Figure, and on Lunar Snow Mountains," has recently been published by Messrs. Dulau and Co. It is shown that evidence of several kinds points to the existence of a vast shoal, or submerged continent, some 1500 miles long by 400 across along the prime meridian. This is presumed to be of greater specific gravity than the refrigerated *maria* east and west of it, and to have been at one time situated in the southern hemisphere. The difference of attraction upon the shoal and the surrounding *maria* is shown to be sufficient both to cause and maintain libration. Since libration began, the shoal has placed itself geocentrically, in which case the south pole must have been drawn forward about 30°. The possibilities of the case seem to be as follows. The moon formerly had a physical constitution the same as that of the earth at the present time. The lunar ocean beds were then steadily subsiding, the lines of upheaval and weakness being on the continents, and causing a series of *quasi*-volcanic orifices. Whilst tidal friction was reducing the velocity of rotation, polar snow-caps were formed, and the atmosphere became rarer. The extension of the snow-cap to the equator was for ages prevented by the incidence of solar heat. This struggle between steadily-increasing refrigeration and solar heat should therefore be evidenced by the existence of an irregular belt about the (then) equator. Such a belt is found in the circular *maria* Smythii, Crisium, Serenitatis Imbrium, and part of Oceanus Procellarum. If the axis of rotation be shifted about 30°, so that the south pole occurs near Nach or Maginus, all these irregular *maria* form a chain of seas along the equator, which may represent the belt of solar influence referred to. Eventually these *maria* were refrigerated, and the meridional shoal, acting as a fixed tide during libration, caused the change in the direction of the axis of rotation, which shifted the belt of seas from their equatorial position to that at present occupied by them.

DOUBLE-STAR OBSERVATIONS.—In *Astronomische Nachrichten*, Nos. 3047 and 3048, Mr. S. W. Burnham gives the results of his double-star observations made in 1890 with the 36-inch equatorial of the Lick Observatory. The stars which have been re-observed are mainly those which cannot easily be measured on account of their being beyond the reach of any but the most powerful telescopes. Mr. Burnham also notes that his purpose has not been to find as many pairs as possible without reference to their character, but to make several measurements of interesting ones. The present catalogue of new stars contains 70 pairs, of which 39 have distances less than 1", with an average distance of 0"·45.

The following naked-eye stars are included in the list of new binaries:—B.A.C. 230, 48 Cephei (H), 5 Camelopardus, τ Herculis, Ceti 199, 34 Persei, ν Geminorum, 24 Aquarii, 95 Piscium, B.A.C. 1142, 36 Geminorum, ψ^1 Aquarii, χ Persei, Tauri 148, 65 Geminorum; and the following pairs, previously known, have been found to be more closely double:—H 1981, S 409, Σ 809, OΣ (app.) 77, Σ 2476, OΣ 425, Σ 12 (app. II.).

OBSERVATIONS OF THE ZODIACAL COUNTER-GLOW.—An account of observations of the zodiacal counterglow, or *Gegenschein*, made at Mount Hamilton from 1888 to 1891, is contributed to the *Astronomical Journal*, No. 243, by Mr. E. E. Barnard. The changes of form previously noted have been confirmed. In the fall of the year the *Gegenschein* appears large and roundish. It afterwards becomes elongated, and connected with the zodiacal light by a narrow zodiacal band. The observations prove that the *Gegenschein* does not lie in the ecliptic, although very nearly so. Neither is it exactly 180° from the sun. The mean of sixteen observations assign the following longitude and latitude to the phenomenon:—

$$\odot - \lambda = 180°{\cdot}6\,;\ \beta = +\ 1°{\cdot}3.$$

THE OBSERVATORY OF YALE UNIVERSITY.—The Report for the year 1890-91 of the Observatory of Yale University contains a report from Dr. Elkin, from which we make the following extracts:—

"In observational work with the heliometer I have been engaged almost wholly in the continuation of the series on the parallaxes of the first magnitude stars in the northern hemisphere. The scheme originally laid out has now been completed, and furnishes for each of the ten stars three (for Arcturus five) independent results.

"The triangulation of the comparison stars for Victoria according to the plan drawn up by Dr. Gill has been carried out by Mr. F. L. Chase, who secured some 450 measures of these stars during the months of June to October 1890. Mr. Chase has also reduced the observations as far as it was advisable for us to do so here, and the results have been communicated to Dr. Gill, along with the reduced results of our observations of Victoria and Sappho in 1889. Since February 1891, Mr. Chase has been engaged in a triangulation of the principal stars in *Coma Berenices*, and up to date about one-half of the proposed measures have been obtained.

"It is proposed during the ensuing season to devote the heliometer to a series of measures on the satellites of Jupiter for the determination of their orbits and the mass of the planet, comparing them *inter se*, as has been done with such success by Hermann Struve at Pulkova with those of Saturn."

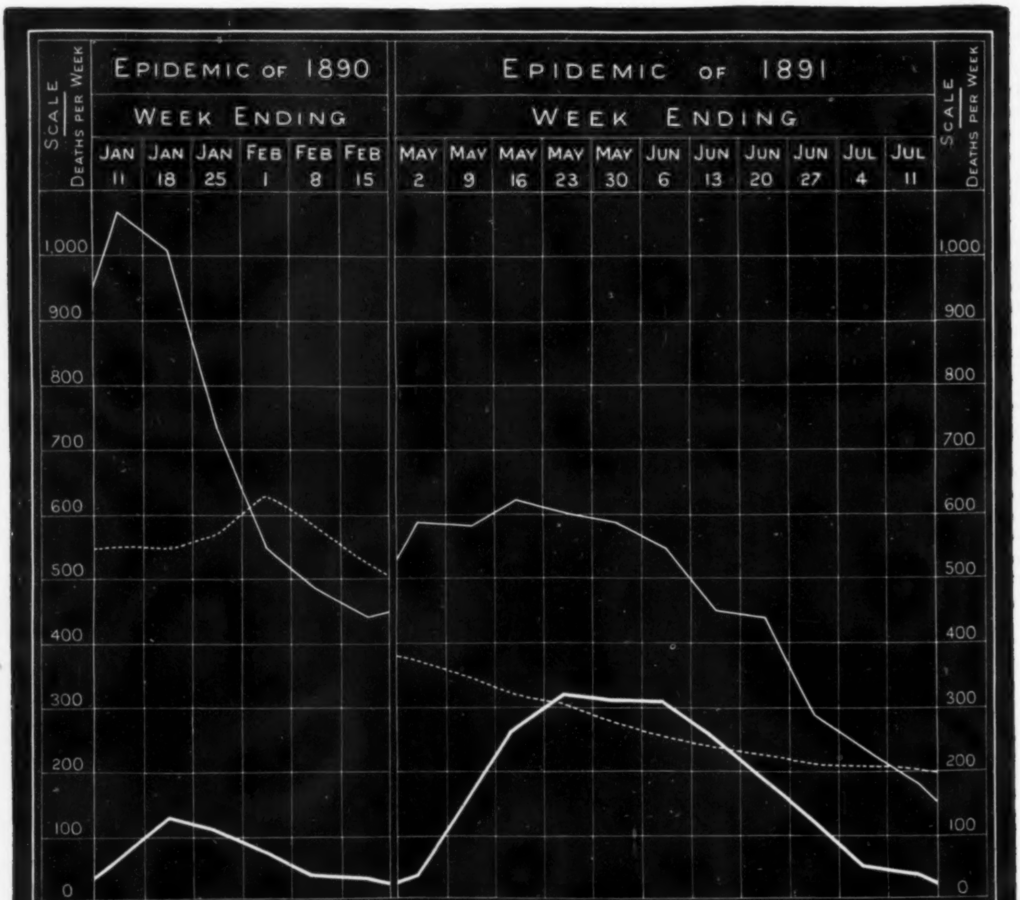
THE RECENT EPIDEMIC OF INFLUENZA.

THE mortality in London from influenza shows a steady decline week by week; and, although the number of deaths is still in excess of the average, there are good reasons for hoping that the epidemic will shortly disappear from our midst. The severity of the recent visitation, as compared with that which prevailed last year, is clearly shown by the accompanying diagram, in which the effects of the two epidemics are displayed side by side. The weekly mortality from influenza alone is represented by the thick curve, the number of deaths

from diseases of the respiratory system by the lighter curve, and the average number of deaths from disorders of the latter class by a dotted line. The average mortality from influenza is too small to permit of any curve being drawn upon the scale shown in the diagram.

Taking into consideration, firstly, the mortality from influenza alone, we find that not only was the duration of last year's epidemic far less than that of the present year, but that the number of deaths in the earlier period was very much smaller than in the latter. The epidemic of 1890 set in with great severity and suddenness at the beginning of January. During the week ending December 28, 1889, there were no deaths in the epidemic prevailed with more or less severity, it appears that the total number of deaths in London was 442, giving an average of 74 per week.

The visitation of the present year may be said to have commenced at the beginning of May. During the whole of April there were a few deaths from influenza, the numbers in the four weeks embraced by the Registrar-General's returns being respectively 7, 3, 9, and 10. By the week ending May 2, however, the number had risen to 37, and from this time onward the disease continued to spread with alarming rapidity, the numbers in the three successive weeks being 148, 266, and a maximum during the week ending May 23 of 319. In the two



London rom this disease, and in the following week only 4. In the week ending January 11, 1890, however, the number had risen to 67, while in the course of the ensuing seven days a maximum of 127 was reached. The mortality then declined steadily, the numbers in the four succeeding weeks being respectively, 105, 75, 38, and 30. As a serious epidemic the visitation may then be regarded as having spent itself, and in preparing the diagram I have not considered it advisable to include any period in which the weekly number of deaths fell below 25. It may, however, be remarked that, for three weeks subsequent to that shown by the curve, the mortality exceeded 20, while in the four succeeding weeks it ranged between 10 and 17. Taking as a whole the period of six weeks in which ollowing weeks the mortality again exceeded 300, after which it declined steadily to 249, 182, 117, and 56, while in the last period shown by the diagram the number had fallen to 40. Taking the period as a whole, it appears that during the eleven weeks ending July 11 the total number of deaths in London from influenza, irrespective of cases in which it was known to have been present in the course of other diseases, was 2027, giving an average of 184 per week, or about two and a half times as much as the average mortality in 1890. In no fewer than seven weeks out of the eleven the number of deaths exceeded the maximum attained during the epidemic of last year.

From an examination of the statistics given in a valuable

paper read before the Scottish Meteorological Society on March 31, 1890, by Sir Arthur Mitchell and Dr. Buchan (an abstract of which appeared in NATURE, vol. xli. p. 596), it is quite evident that the recent epidemic of influenza has been the most severe we have had in London since the first publication of weekly records of mortality some forty-five years ago. As the figures are of great interest, we make no apology for reproducing the brief table given in that paper, showing the number of deaths which occurred in the five principal epidemics experienced since the year 1847. It will be observed that the number given for last year is considerably in excess of that quoted above, the period selected by the authors of the paper comprising the whole of the three months January to March. In the month last mentioned, the epidemic was certainly not of any great severity, but as the figures do not clash in any way with the general argument, I have not thought it advisable to alter the results. An addition has, however, been made to the table, by including the figures of mortality reached during the epidemic of the present year.

	Deaths.
December 1847 to April 1848	1631
March to May 1851	258
January to March 1855	130
November 1857 to January 1858	123
January to March 1890	545
May to July 1891	2027

It will be seen from the table that the mortality recently experienced has been far greater than at any other period during the forty-five years, the nearest approach to so severe an epidemic being in 1847–48, when the deaths amounted to about 400 less. Taking into consideration the fact that the population of London 45 years ago was very much smaller than it is now, it may at the first blush appear that, as regards severity, there was not very much to choose between the two visitations. It must not be forgotten, however, that in the earlier period the ravages of the disease extended over five months, while in the latter they were confined to about two and a half.

A very striking feature in the disease to which the somewhat misleading name of influenza has been given, is its peculiarly weakening effect upon the lungs and bronchial tubes; and as the epidemic is invariably attended by a high mortality from respiratory diseases, I have included in the diagram a series of curves showing the number of deaths from these attendant disorders. As regards the epidemic of 1890, it may at once be confessed that the curve is somewhat misleading. During the last few days of 1889 and the opening of the following year a sharp touch of anticyclonic cold was experienced over England; and in the metropolis this was accompanied, as is so commonly the case, by thick fog. Under such circumstances a high mortality from respiratory diseases followed as a matter of course, so that when we examine the curve we find that, at the time when the epidemic of influenza was only just appearing, the deaths from lung disorders were at their maximum. After the first week in January, however, the weather became unusually mild for the time of year, a long period of south-westerly winds setting in, with abnormally high temperatures. There can be little doubt, in fact, that at the time the influenza epidemic of 1890 was raging the effects of temperature and weather were so strong as to obliterate the influences of the miasmatic disorder upon diseases of the respiratory system. This year, however, the meteorological element may almost be eliminated from account, for, although cold winds were very frequent in May and the early part of June, the severity of the weather was not such as to lead to any material increase of mortality from the class of diseases in question. The spread of influenza was, however, soon followed by a serious rise in the death-rate, and in the course of the fortnight ending June 6 the mortality from respiratory complaints amounted to more than twice the average, the large excess being due chiefly to deaths from pneumonia and bronchitis. The subsequent decline of influenza was accompanied, as will be seen from the curve, by a corresponding decline of fatalities from respiratory diseases, but it was not until the last week of the period that the deaths fell short of the average. Taking the eleven weeks as a whole, it appears that the total mortality from respiratory disorders amounted to 5138, or about 75 per cent. more than the average. During the epidemic of 1890 the actual number was far larger, but in the winter months the average is also very much higher, and as a matter of fact the excess above the normal only amounted last year to 26 per cent.

The influence of the weather upon the two epidemics seems to have been exerted in entirely opposite directions. During the epidemic of 1890 temperature was, as we have already seen, for the most part very high for the time of year, and the prevalence of a strong current of south-westerly winds in January doubtless aided in the dispersal of the miasmatic germs. The weather was, in fact, as favourable as could have been desired, and the ravages of the epidemic, severe though they were, were doubtless much milder than they would have been had the winter been cold and foggy. The recent epidemic has not had so many foes to contend with, for in the earlier stages of its career the weather was not only cold for the time of year but also calm and quiet. The germ was therefore able to settle in our midst without serious opposition, and the ungenial nature of the atmosphere has doubtless been responsible for much of the lung and bronchial disease which has followed in its train. Deluded by the knowledge that the spring season was upon us, and forgetful of the fact that it had come in an unkindly guise, many a weakly convalescent has been emboldened to venture out into the chilly air, and has contracted a serious cold, from which in too many cases he has been unable to recover. FREDK. J. BRODIE.

THE MUSEUMS ASSOCIATION.

THE Museums Association held its second annual meeting in Cambridge on July 7, 8, and 9, under the presidency of Mr. John Willis Clark, Superintendent of the Museum of Zoology and Comparative Anatomy, Cambridge, and Registrary of the University.

The following representatives of Museums (outside Cambridge) and associates were present:—The Rev. H. H. Higgins, Mr. R. Paden (Liverpool); Mr. R. Cameron, Mr. J. M. E. Bowley (Sunderland); Mr. G. B. Rothera, Mr. J. W. Carr (Nottingham); Mr. Councillor P. Burt, Mr. J. Paton (Glasgow); Mr. T. W. Shore (Southampton); Lieut.-Colonel Turner, Mr. J. Tym (Stockport); Alderman W. H. Brittain, Mr. E. Howarth (Sheffield); Mr. Joseph Clarke, Mr. G. N. Maynard (Saffron Walden); Mr. J. Storrie (Cardiff); Mr. Butler Wood (Bradford); Mr. C. Madeley (Warrington); Mr. I. Lyon, Mr. J. J. Ogle (Bootle); Mr. W. E. Hoyle (Owens College, Manchester); Mr. H. M. Platnauer (York); Mr. F. W. Rudler, Mr. F. A. Bather, Mr. A. Smith Woodward.

The proceedings were opened by the Rev. H. H. Higgins (Past-President), who introduced the President, Mr. J. Willis Clark. The President then read his address, and gave a short and very interesting account of the early history of Cambridge and of the foundation of a few of the older Colleges. On the 8th and 9th the following papers and reports were read and discussed:—

"On some old Museums," by Prof. A. Newton, F.R.S.

"On the desirability of exhibiting, in Museums, unmounted skins of birds," by the Rev. H. H. Higgins.

"On difficulties incidental to Museum demonstrations," by F. W. Rudler.

"On the Dresden Museum cases," by Dr. A. B. Meyer.

"On the registration and cataloguing of Specimens," by W. E. Hoyle.

"Some recent Museum legislation," by E. Howarth.

"On the arrangement of Rock Collections," by H. M. Platnauer.

"Fossil Crinoidea in the British Museum" (an attempt to put into practice modern ideas of Museum arrangement), by F. A. Bather.

"On Tables and Chairs," by F. A. Bather.

The Report of the Committee appointed to consider the question of securing the aid of specialists.

The Report of the Committee appointed to consider the question of labelling in Museums.

The meeting was eminently pleasant and successful, thanks to the untiring energy and exertions of the President and of Mr. S. F. Harmer (Fellow of King's College), the Local Secretary and Treasurer. Under their guidance several colleges, libraries, and laboratories were visited. Prof. Middleton conducted a party over the Fitzwilliam Museum, and, through the kindness of Prof. Newton, a few of the members visited the Pepysian Library.

TECHNICAL EDUCATION IN INDIA.

SIR AUCKLAND COLVIN, the Governor of the North-Western Provinces of India, has issued an exhaustive minute on technical education in that country, in which the various steps towards the introduction of this system of instruction are summarized. The minute naturally refers chiefly to the North-Western Provinces, but is in fact a summary of what has been done elsewhere. It seems that the idea of introducing technical education in the North-West Provinces, where there has hitherto always been a steadily increasing demand for University education, was first mooted in September 1885, when the attention of the local Government was called to the Madras scheme, which aimed at promoting instruction in industrial arts and manufactures by offering grants-in-aid to encourage the teaching, in schools so aided, of technical science, arts, and handicrafts, and by testing that teaching by a system of public examinations. Nearly a year later the Home Secretary to the Government of India drew up a note on the subject generally, pointing out that there was room for improvement in this branch of education in the great north-west, and inquiring what was being done. The Director of Public Instruction replied that the question of establishing Faculties of Medicine and Engineering was under consideration in the Allahabad University, and also certain preparatory courses of study, while it was proposed to refer the question of agricultural and veterinary schools to the Local Records Department. In January 1888, Colonel Forbes, replying to questions addressed to him regarding instruction in engineering, said he considered that the practical instruction gained by natives in the large railway workshops at Allahabad, Lucknow, and Lahore, and at the Government workshops at Roorkee, was decidedly bearing fruit in the direction of enabling natives to take intelligent and independent control in these branches of technical industry. The railway and Government workshops he considered were the real technical schools so far as this branch of instruction was concerned, and there was no need, therefore, for the Government to establish technical engineering schools. Facilities might be given to selected students at the middle and high schools to go through a four or five years' course at these workshops, but more than that he held was unnecessary. Colonel Brandreth, the Principal of the Thomason College, was unfavourable to any school for technical education for the youthful masses, but would provide special opportunities for exceptional young men, though such opportunities need only be limited in number. "For the higher grades of engineering, I think the ordinary liberal education with a scientific knowledge is most suited, until a man is of an age to know his mind, and elect for the profession, when there should be a strictly technical education for a limited time, two or three years, followed by a careful apprenticeship on works." The late Colonel Ward contended that facilities should be given at the Roorkee College for practical instruction, in addition to the present theoretical course. "If such a technical practical class were formed at Roorkee, students from the schools might be allowed to attend it without going through the College theoretical course." Later on, the Director of Land Records and Agriculture sent in an opinion on the subjects immediately referred to him, and advocated nothing more than the creation of a normal school for survey only, at Cawnpore or Lucknow, suggesting also the establishment of small scholarships for the maintenance of boys in training at the various workshops in the provinces; of an art school at Lucknow; and of agricultural and veterinary schools or classes in high schools; and he proposed that drawing should be made compulsory, competency to teach drawing being prescribed as an essential qualification in all teachers in middle and high class schools. And finally, the Inspector-General of Civil Hospitals reported against the proposal to teach up to a higher standard than that of the hospital assistant class. Then, in March 1888, the Director of Public Instruction forwarded a second report adverse to the establishment of a school of art at Lucknow, and pointing out further that, however desirable was the proposal to introduce drawing into public schools, there were no funds available for the purpose. At the close of the year the Director forwarded a resolution, on the part of the Senate of the Allahabad University, to the effect that any steps to establish a College for training medical practitioners would at present be premature. At this point, says the *Times of India*, in discussing Sir Auckland Colvin's minute, the cold water current ceased. In the February of last year the Director of Public Instruction forwarded a minute by the Allahabad Senate, it which it was decided to establish a Faculty of Engineering, degrees being conferred on men who had passed at least a three years' theoretical course at a properly constituted Engineering College or school. On this subject Sir Auckland Colvin now reports that, so far as he is able to gather, the only place at which engineering can be studied in the North-West Provinces is Roorkee. The Public Works Department, he adds, is of opinion that if degrees are to be conferred by the Allahabad University the Roorkee certificate must be abolished, and the Department prefers Roorkee certificates. In this dilemma the resolution of the Senate has not yet been forwarded to the Government. Then the establishment by the University of a special examination of "a commercial and practical character," aiming apparently at forming a sort of training class for technical education, still remains under consideration. The general conclusion, Sir A. Colvin thinks, is that, on the whole, opinion points to nothing more urgent or pronounced than the expediency of giving greater facilities for obtaining instruction in the subordinate grades of practical engineering, and in the handicraft of the artisan. Sir Auckland Colvin then sums up the subsequent papers on the subject, relating to the offer of the British Indian Association, in July 1887, to establish and maintain, at a cost to the Association of Rs. 500 per month, a school of industry in one of the Wingfield Manzil buildings; the announcement of Munshi Imtiaz Ali of additional individual subscriptions, reaching Rs. 17,440 per annum; to the speeches of Sir Alfred Lyall on the subject; and to the draft rules forwarded by the British Indian Association.

Sir Auckland next devotes himself to a consideration of the systems of technical instruction at work in Bombay and Bengal. From a careful study of the facts and the more or less voluminous papers in which they were originally enshrined, he proceeds to define what is meant by technical education so far as it is applicable to the North-West Provinces. Technical education in Europe he illustrates by Mr. Scott Russell's words: "It is necessary that each individual shall, in his own special profession, trade, or calling, know more thoroughly its fundamental principles, wield more adroitly its special weapons, be able to apply more skilfully its refined artifices, and to achieve more quickly and economically the aim of his life, whether it be commerce, manufactures, public works, agriculture, navigation, or architecture;" and by an extract from Mr. Kirkham's report, in February 1889, to the Bombay Government: "The general principles that the real technical school is the actual workshop—that actual workshops are only called into existence by capital operating in accordance with its own law—that this training, so far as it can be given in schools or colleges, must be, in the main, preparatory and disciplinary, and that the improvement of science teaching all round, and the spread of a practical knowledge of drawing, are the indispensable preliminaries of any form of practical training." But however unanimous the authorities may be so far as the principle of the matter is concerned, directly they come to the practical details there is, as Mr. Kirkham admits, every degree of diversity of opinion, and every system is of course bound in a way to differ from every other system, just as the leading industries of different districts differ. Apart from this, however, the Bombay system was found to be far too elaborate for the North-West Provinces. From Bengal Sir Alfred Croft wrote a very practical and sensible letter, condemning the abolition of the Seebpore workshops, and urging that the primary point, so far as engineer students were concerned, was to learn how to use their hands. He also quoted Mr. Spring, who says there can be no question as to their superiority for public works employment if the men have gone through the course of manual training. "An engineer who has learned to use his hands is, other things being equal, an all-round better and more useful man than one who has not." Sir A. Croft goes on to further condemn the removal of the Seebpore shops from the point of view of the need of the mechanic class. "It may be freely admitted and taken as proved that the maintenance of the shops is undesirable from the point of view of the Public Works Department. But it is no less clear to me that the interests of that Department are in this matter antagonistic to those of technical education; and that the deliberations of the Committee have been chiefly governed by regard to the former." The Government, however, remained in principle unmoved; but happily in practice they agreed with the Director of Public Instruction, and the Government of India followed suit; thus establishing a very important principle in regard to technical education. Armed with all this experience, and conceding for the moment the

existence of a demand for men competent to deal with machinery and familiar with all the lower forms of engineering, Sir A. Colvin proceeds to discuss what course the training should take, how best to secure it, and the sources from which the necessary funds could be obtained. With regard to the first point, he thinks that what would mostly be required are facilities for gaining a competent theoretical and practical knowledge of the more subordinate grades of mechanical engineering, such as is necessary to a foreman mechanic, more especially in connection with the steam-engine, the railway workshops, and the iron-foundry; and also of the processes of cotton-spinning as employed in the mills established in the North-West Provinces. "These are the two great branches of industry which in Bombay have been recognized as fields for native labour: which, though in a lesser degree, exist here (in the North-West Provinces), and in regard to which, at present, specialized means of instruction are unquestionably, in these provinces, wanting." With regard to the second point, there exists at Roorkee a Government Engineering College and Government workshops, and it seems probable that these will form the nucleus of the instruction necessary. As to the third point, Sir Auckland Colvin thinks it would be premature to enter into the question of funds until the dimensions of the scheme are definitely decided upon. Finally, to see how far all these views meet the industrial needs of the province, Sir Auckland has decided to seek the aid of a strong Committee, which will obtain from all available quarters information on the points indicated in the minute, deputing members to Calcutta, Bombay, and Madras, and subsequently reporting to Government the result of its inquiries, with its own recommendations, and with full details of any scheme which it may desire to see carried into effect.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The judges for the Johnson Memorial Prize, 1891, have awarded the prize to Mr. M. S. Pembrey, B.A., Christ Church. The judges also select the essays of the following as worthy of mention: Mr. T. I. Pocock, Scholar of Corpus Christi College, and Mr. F. T. Howard, B.A., Balliol College. The Johnson Prize consists of a gold medal of the value of ten guineas, together with the surplus dividends on the money invested. The prize is awarded every fourth year to the candidate who produces the best essay on some subject connected with astronomy or meteorology. The selection of a subject is left to the discretion of the candidates. This year there were six candidates.

Mr. Pembrey was a Fell Exhibitioner of Christ Church, gained a first class in the final honour school of natural science in 1889 (physiology), and obtained the Radcliffe Travelling Fellowship in 1890. Mr. Pocock was placed in the first class of mathematical moderations and also in the final mathematical schools, Trinity term 1891. Mr. Howard was placed in the second class of the final honour school in natural science (geology), and obtained the Burdett-Coutts Scholarship in 1890.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, June 18.—Prof. A. Crum-Brown, F.R.S., President, in the chair.—The following papers were read:—A note on some new reactions of dehydracetic acid, by Dr. J. Norman Collie. In preparing dehydracetic acid, by passing ethyl aceto-acetate through a red-hot tube, it is stated that alcohol is formed; the author finds that large quantities of ethylene gas and acetone are also produced. Dehydracetic acid is also volatile to a considerable extent with steam, and is decomposed by boiling with water to a small extent into carbon dioxide and dimethylpyrone. This latter decomposition is more readily effected by boiling the acid with strong hydrochloric acid. If 50 grams are boiled with ordinary fuming hydrochloric acid, the whole is converted into carbon dioxide and a soluble compound of dimethylpyrone with hydrochloric acid. The barium salt of dehydracetic acid, $(C_8H_9O_5)_2Ba$, seems to be not a salt of the compound $C_8H_8O_4$, but of the true tetracetic acid, $C_8H_{10}O_5$. A very stable copper salt of the formula $C_{24}H_{25}O_9N_3Cu$ is obtained if dehydracetic acid be added to a solution of copper acetate in a large excess of ammonia.—The lactone of triacetic acid, by Dr. J. Norman Collie. In a former paper on the constitution of dehydracetic acid (Trans. Chem. Soc., 1890, 189) the author pointed out that if the formula which he proposed for dehydracetic acid was correct, it would be the δ-lactone of tetracetic acid. And the following list was given showing the connection between the condensed acids formed from acetic acid: $CH_3CO.(CH_2CO)_2.CH_2COOH$, tetracetic acid; $CH_3CO.CH_2CO.CH_2COOH$, triacetic acid; CH_3COCH_2COOH, diacetic acid; CH_3COOH, acetic acid. At that time no acid corresponding to the triacetic acid was known. Since then the author has obtained the lactone of this acid by the action of 90 per cent. sulphuric acid on dehydracetic acid at a temperature of 130°–135°. The properties and reactions of the new compound are described.—The refractive power of certain organic compounds at different temperatures, by Dr. W. H. Perkin, F.R.S. The magnetic relations of substances when examined at temperatures wide apart show that certain variations take place after allowing for change of density. Experiments have been made by the author in reference to the refractive power of liquids under similar circumstances. The results show that the specific refractive power is not constant for all temperatures. By comparing the lines A and F it was found that the dispersion was slightly diminished by rise of temperature. The results were calculated by the formula $\frac{\mu - 1}{d}$. When calculated by Lorentz's formula the numbers gave higher results for high temperatures than for lower ones.—Note on a volatile compound of iron and carbonic oxide, by Ludwig Mond, F.R.S., and Dr. F. Quincke (see NATURE, July 9, p. 234).—The formation of salts, a contribution to the theory of electrolysis and of the nature of chemical change in the case of non-electrolytes, by H. E. Armstrong. The author draws attention to the recent researches of Claisen, W. Wislicenus, and others, which clearly show that ethereal salts form compounds with sodium ethylate, and to the bearing which these results have on the theory of the formation of salts generally. It may be supposed that the acid and the "base" in the first instance combine, and that the salt is formed by subsequent interactions within the molecule. In like manner, acids form dissociable compounds with water, and by the occurrence of change within such systems, under the influence of electromotive force, electrolysis is effected. When the compound is highly unstable, the opportunity for change within its system is slight, the acid is a weak one, and its solution of relatively low conducting power. In the case of non-electrolytes, the occurrence of change may be supposed to occur within complex systems formed by the union of the interacting substances.—Dibenzyl ketone, by Dr. S. Young. The author finds that, in preparing the ketone by heating calcium phenyl acetate in a combustion furnace, only 27 per cent. of the theoretical yield is obtained. However, if the calcium salt be heated by means of the vapour of boiling sulphur, the yield of pure ketone amounts to 76·6 per cent.—The vapour-pressures of dibenzyl ketone, by Dr. S. Young.—The vapour-pressures of mercury, by Dr. S. Young. Two additional observations of the vapour-pressures of mercury at 183°·75 and 236°·9 have been made, and, from the previous results of Ramsay and Young, the boiling-point and the vapour-pressures of mercury have been recalculated.

June 25.—Extraordinary General Meeting.—At the request of certain Fellows to the President, an extraordinary general meeting was summoned to consider a proposal for amending and altering the by-laws. The proposal was moved by Mr. James Wilson and seconded by Dr. Teed. Mr. Cartrighe moved the following amendment: "That this meeting declines to pledge itself to any amendment or modification of the by-laws which has not been approved and recommended to the Fellows for adoption by the Council." Sir F. A. Abel seconded the amendment. Mr. Cassell, Mr. Lloyd, and Dr. Newton spoke in favour of the original motion. Prof. Tilden, Mr. Warington, Mr. Page, Dr. Odling, and Mr. Friswell spoke in favour of the amendment. The amendment was carried by 137 votes to 47 votes.

PARIS.

Academy of Sciences, July 13.—M. Duchartre in the chair.—Calculation of the mean length that a circular tube widened at one end should have in order that a sensibly uniform *régime* might be established, and on the expenditure of the charge that entails the establishment of this *régime*, by M. J. Boussinesq.—Contribution to the study of what are called *natural* prairies, by M.

A. Chatin.—On alkyl cyanides, cyanobenzene, and orthocyanotoluene, by M. A. Haller.—Experimental aërodynamic researches and experimental data, by Prof. S. P. Langley (see p. 277).—Observations of solar spots and faculæ, made with the Brunner equatorial of Lyons Observatory, during the first six months of this year, by M. Em. Marchand.—On a modification of the method of supporting railway and tramway vehicles, by M. Féraud.—On the measurement of capacity, self-induction, and mutual induction by experiments on aërial wires, by M. Massin.—On a new copper hydride and the preparation of pure nitrogen, by M. A. Leduc. The new body was discovered in the course of some experiments on the preparation of pure nitrogen by passing undried air deprived of CO_2 over copper turnings in a glass tube heated to redness and then reducing the resulting oxide by hydrogen. The composition and properties of this hydride have not yet been studied, but from the fact that it is formed at red heat it appears to differ from the body discovered by Wurtz, which is broken up at about 60° C.—Action of light on silver chloride, by M. Guntz. The experiments indicate that when a layer of silver chloride is exposed to light it becomes divided into three superficial layers, the first of which is metallic silver; the second silver subchloride; and the third unaltered silver chloride. These three layers have a thickness which is a function of the duration of exposure, and of the primitive thickness of the layer of silver chloride experimented upon.—On a new gaseous compound, phosphorus pentafluochloride, by M. C. Poulenc. The formation of this compound is expressed by the formula $PF_3 + Cl_2 = PF_3Cl_2$, which also indicates that a contraction of volume occurs. This has been proved experimentally. The gas is colourless, and has an irritating odour. Its density is 5·40, and it may be liquefied at ordinary pressures by reduction to a temperature of $-8°$. Reactions with sulphur, phosphorus, sodium, magnesium, mercury, and various other substances, are described. It appears to be a much less stable body than Prof. Thorpe's phosphorus pentafluoride.—Compound of boron bromide with phosphoretted hydrogen; phosphide of boron, by M. A. Besson. Bromide of boron absorbs phosphoretted hydrogen at ordinary temperatures, and the result of the combination is a white, amorphous, very light solid. The composition of this product appears to be represented by the formula BBr_3PH_3. At about 300° it changes colour, and hydrobromic acid is disengaged. The dark brown body that remains is found to contain only phosphorus and boron, the action that takes place being expressed thus—$BBr_3PH_3 = PB + 3HBr$. Boron phosphide has a density about the same as water, in which it is insoluble. Reactions with various substances have been investigated.—Researches on the zirconates of the alkaline earths, by M. L. Ouvrard. One interesting point brought out by the experiments is that an analogy exists between zirconium, tin, and titanium.—Artificial production of datolite, by M. A. de Gramont. By the action of a solution of borate of sodium on silicate of calcium (formed by the precipitation of calcium chloride by sodium silicate) at a high temperature and under pressure, a hydrated silico-borate of calcium has been obtained, which in composition and physical properties appears to be identical with datolite. This is the first silico-borate of definite composition, and corresponding to a natural product, which has yet been obtained.—Action of boron fluoride on nitriles, by M. G. Patein.—On the acid sulphate waters containing iron and aluminium of the environs of Rennes-les-Bains (Aude), by M. Ed. Willm.—On the formation and oxidation of nitrites during nitrification, by M. S. Winogradski.—On the larva form of Parmophori, by M. Louis Boutan.—On the circulatory and respiratory apparatus of some Arthropods, by M. A. Schneider.—On the genus *Euclea* (Ebenaceæ), by M. Paul Parmentier.—On the structure of the primary libero-ligneous system, and on the disposition of foliary traces in the branches of *Lepidodendron selaginoides*, by M. Maurice Hovelacque.—On a fall of small calcareous stones which recently occurred in the Department of the Aude, by M. Stanislas Meunier.

AMSTERDAM.

Royal Academy of Sciences, June 27.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Pekelharing communicated that magnesium-sulphate-plasma or kalium-oxalate-plasma contains a substance which has no active power on pure fibrinogen, but acquires by a combination with lime-salts all the properties of fibrin ferment prepared from washed blood-clot. This substance is precipitated incompletely by dialysis, and completely by saturation with magnesium-sulphate. Its combination with lime is active also in the presence of ammonium-oxalate. In the formation of fibrin, lime is transferred from the ferment to the fibrinogen. Pepton prepared by neutralizing the hydrochloric acid of the digesting fluid with calcium-carbonate, injected in the jugular vein of the dog, does not prevent the clotting of the blood. Wooldridge's "tissue-fibrinogen," prepared from the thymus of the calf, causes coagulation of a pure solution of Hammarsten's fibrinogen when lime-salts are present.—Mr. van Bemmelen communicated a research of Mr. Schreinemaker's on the equilibriums which are possible between the double salt $PbI_2 2KI$ and water, in the presence or the absence of an excess of one of the components, or of the double-salt itself, or of both. The results are in accordance with the investigations of Dr. Bakhuis Rooseboom.—Mr. Suringar presented to the Academy a new (third) contribution to our knowledge of the Melocacti of the West Indies.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Life of Thomas Sopwith, F.R.S.: B. W. Richardson (Longmans).—Plane Trigonometry: Todhunter and Hogg (Macmillan).—Science or Romance?: Rev. J. Gerard (London).—Les Science Naturelles et l'Éducation: T. H. Huxley (Baillière).—Glasgow and West Scotland Technical College Calendar, 1891–92 (Glasgow, Anderson).—Dictionary of Political Economy, Part 1; edited by R. H. I. Palgrave (Macmillan).—The Total Eclipse of the Sun, January 1, 1889; Report of Washington University Eclipse Party (Camb., Mass., Wilson).—Contents and Index of the first twenty volumes of the Records of the Geological Survey of India, 1886 to 1887 (Calcutta).—Natural Religion in India: Sir A. Lyall (Cambridge University Press).—Journal of Anatomy and Physiology, new series, v., Part 4 (Williams and Norgate).—Photographic Quarterly, vol. ii. No. 8 (Hazell).—Photographic Reporter (Hazell).—Memoirs of the Geological Survey of India, vol. xxiv., Part 3 (Calcutta).—Records of the Geological Survey of India, vol. xxiv., Parts 1 and 2 (Calcutta).

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